The US Army's Center for Strategy and Force Evaluation

STUDY REPORT
CAA-SR-96-2

PRIORITIZATION OF ARMY STRATEGIC MOBILITY PROGRAM RESOURCES (PASMPR)
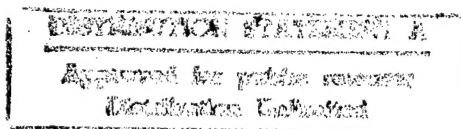
MAY 1996

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13. ABSTRACT (Maximum 200 words)

The US Army has become a force based primarily in the United States, which increases the need to transport units rapidly overseas. The study is sponsored by ODCSLOG, and involves the prioritization of about 400 deployment enhancement projects that are competing for funding in the 1996-2001 timeframe, at a cost of about $4 billion. A large-scale mixed integer programing formulation is presented to solve the problem of deciding which projects should be funded to improve the responsiveness of the Army to react to conflicts. The objective is to minimize the weighted sum of brigade-size unit lateness based on arrival time requirements in given operation plans and scenarios. The weights are derived based on a risk analysis that relates unit arrival sequence to combat outcomes. Constraints include restrictions on expenditures by year and appropriation allowable funding profiles, and sequential nature of the implementation of candidate projects. Performance aspects of the model will be discussed and results will be given.

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May 1996

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REPLY TO
ATTENTION OF

CSCA-VA (5-5d)

0 4 APR 1997

MEMORANDUM FOR Deputy Chief of Staff for Logistics, 500 Army Pentagon, ATTN: DALO-TSM, Washington, DC 20310-0500

SUBJECT: Prioritization of the Army Strategic Mobility Program Resources (PASMPR) Study

1. Reference memorandum, Office of the Deputy Chief of Staff for Logistics, U.S. Army, 30 Jan 95, subject: Prioritization of Army Strategic Mobility Program Resources (PASMPR) Study Directive.

2. The Deputy Chief of Staff for Logistics, Transportation, Energy, and Troop Support (DAMO-TSZ), in referenced memorandum, requested that the U.S. Army Concepts Analysis Agency, develop a methodology to assist in the prioritization of ASMP initiatives.

3. The final report documents the results of our study and incorporates your comments on the draft report which were received in December 1996. Questions and/or inquiries should be directed to the Value Added Analysis Division, ATTN: CSCA-VA, 8120 Woodmont Avenue, Bethesda, MD 20814-2797, DSN 295-0211.

4. This Agency expresses appreciation to all commands, staff elements and agencies which have contributed to the PASMPR Study.

Encls

E. B. VANDIVER III
Director

	PRIORITIZATION OF ARMY STRATEGIC MOBILITY PROGRAM RESOURCES (PASMPR)	STUDY SUMMARY CAA-SR-96-2

THE REASON FOR PERFORMING THE STUDY was to support the Office of the Deputy Chief of Staff for Logistics (ODCSLOG), Directorate of Transportation, Energy, and Troop Support (TETS) in making funding and prioritization decisions concerning initiatives proposed under the Army Strategic Mobility Program (ASMP) initiatives and derived as a response to Mobility Requirements Study (MRS) concerns.

THE STUDY SPONSOR was the ODCSLOG Director of Transportation, Energy, and Troop Support (DALO-TSZ).

THE STUDY OBJECTIVE was to develop a tool to support ASMP prioritization decisions and funding strategies, designed to improve US Army mobilization capability.

THE SCOPE OF THE STUDY encompassed the Southwest Asia (SWA) scenario and resulting force structure of the MRS. The cost and budget data is relevant for fiscal year (FY) 96-FY 01. ASMP initiatives to be considered were provided by the sponsor.

THE MAIN ASSUMPTION of this work is that appropriate funding strategies and prioritization decisions can be modeled by observing tradeoffs among initiative costs, resource availabilities, funding strategies, and expected improvements to unit arrival times.

THE BASIC APPROACH used in this study was to:

(1) Identify the data needs associated with each initiative and unit to be examined.

(2) Determine the level of aggregation required for both initiatives and units.

(3) Develop a mixed integer program (MIP) to serve as the basis of a decision support tool.

(4) Demonstrate the use of the methodology using 37 initiative packages and 15 unit packages.

THE PRINCIPAL FINDING of this work is that the PASMPR methodology can be used to evaluate the effect of variations in budget increments and decrements, funding strategies, and prioritization schema; the results are limited by the availability and quality of data on the expected benefit of each ASMP initiative or initiative package.

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PRIORITIZATION OF ARMY STRATEGIC MOBILITY PROGRAM RESOURCES (PASMPR)

CHAPTER 1

EXECUTIVE SUMMARY

1-1. PROBLEM. In order to maintain an emphasis on power projection, it is necessary to have objective decision support tools to assist in determining relative priorities of initiatives proposed under the Army Strategic Mobility Program (ASMP) and competing for available resources as funding increments or decrements occur.

1-2. OBJECTIVE. The aim of this study is to develop and demonstrate such a decision support tool utilizing a methodology which incorporates cost-benefit tradeoff analysis in evaluation of the various ASMP initiatives.

1-3. BACKGROUND. With the intent to improve and maintain readiness, the ASMP is a set of tasks and initiatives designed to ensure the deployment of Army forces in the fastest and most efficient manner possible. The ASMP was developed as a response to deployment lessons learned in DESERT SHIELD/DESERT STORM with projects scoped in conjunction with requirements from the Congressionally-mandated Mobility Requirements Study (MRS).

1-4. SCOPE

    a. Scenario/Forces. The scenarios and resulting force structure of the MRS are utilized for the demonstration (proof of principle) case. However, both the methodology and resulting model are robust enough to accommodate future scenarios and force structures.

    b. Theater. Southwest Asia (Iraq), as represented in the MRS scenario, is the theater chosen for the demonstration case. It was found to be a sufficiently large test case to stress the model.

    c. Timeframe. This analysis mirrors the Program Objective Memorandum (POM) cycle, fiscal year (FY) 96-FY 01.

    d. Model Size

        (1) Variables. There are over 500 initiatives in the ASMP, currently aggregated into 37 packages. Units are also aggregated, consisting of 15 packages varying in size from brigade slices to Corps Support Command (COSCOM). For purposes of the demonstration, 15 unit packages are currently being modeled.

        (2) Mixed Integer Program. The result of the aggregation and packaging of the data is a mixed integer program (MIP) with 480 noninteger variables, 704 constraints, and 338 integer variables.

1-5. LIMITATIONS

    a. Funding patterns are limited to contiguous years.

    b. Partial funding is not allowed.

    c. Appropriations are evenly distributed over the 6-year POM cycle due to the lack of annual program data at the time the prototype was developed.

1-6. KEY ASSUMPTIONS

    a. The scenarios and forces used are adequate to measure the effectiveness of candidate ASMP initiatives.

    b. The relative unit importance weights are assumed to reflect decision maker positions as seen in the Time-Phased Force Deployment Data (TPFDD) for the given scenario, further structured by actual simulation results which measure outcomes as a function of arrival schedules. This analysis provides a means of modeling the effect of units with untimely arrivals.

    c. The effectiveness data used will reasonably assess and express the effects of implementing the proposed ASMP initiatives on closure times of Army units, given a specific scenario and force structure.

    d. Aggregation of initiatives is adequate to capture the decision space.

    e. Railcars and containers are not procured until infrastructures are completed for the same location due primarily to concerns over the cost of leasing storage space.

1-7. METHODOLOGY. This methodology incorporates a value added paradigm for optimizing funding strategies across mobilization projects.

    a. Identify the data needs associated with each ASMP initiative examined and those units to be affected.

    b. Determine the level of aggregation required for both initiatives and units.

    c. Develop a MIP to serve as the basis of a decision support tool. The resulting model utilizes cost-benefit tradeoff analyses, maximizing the benefit to affected units, subject to constraints on resource allocation, procurement quantities, funding strategies, and required unit arrival times.

    d. Demonstrate the use of the methodology using the 37 initiative packages and 15 unit packages.

1-8. ESSENTIAL ELEMENTS OF ANALYSIS (EEA)

1-8. ESSENTIAL ELEMENTS OF ANALYSIS (EEA)

a. Does the proposed mathematical programming formulation satisfy the analytical requirements of this study at the required level of sensitivity? Yes. It is imperative that, when looking at dissimilar classes of ASMP initiatives, there is a common unit of measure that can be applied across all projects regardless of whether one is looking at prepositioned (PREPO) afloat or a depot railyard upgrade. The measure chosen for this analysis is the days of improvement in meeting a required closure date. This common measure of effectiveness (MOE) enables the employment of cost effectiveness tradeoff analysis as an integral feature of the formulation. The single greatest advantage of this approach is that it addresses the two major concerns of the ASMP program managers: what does the Army gain, and is the ASMP within budget? Sensitivity in this case relates to the level of aggregation at which questions may be addressed. This issue is addressed as a separate EEA (see 1-7b).

b. What level of aggregation yields results that are relevant to the issues and concerns being addressed by ASMP decision makers? As is clearly shown in the proof of principle illustrated in Chapter 4, an installation-level aggregation is not sufficiently detailed to answer the questions relevant to the ASMP decision makers. One is forced to evaluate tradeoffs among entire installation packages of ASMP projects and is not able to look at the more interesting questions of what to fund within an installation's requests. Therefore, in order to provide the best information possible, one would prefer to have data on each initiative, or as a minimum requirement, for each functional grouping of initiatives at a particular location, i.e., rail vs air. Neither course, however, was available at the time of this analysis due to the lack of data at that level of detail.

c. What is the allocation of available ASMP funds to the proposed initiatives which best enables the realization of overall force closure objectives? The proof of principle demonstrates that it is possible to use this methodology to develop a funding allocation plan for the period of the POM. Table 4-1, Chapter 4, lists the year(s) in which funding would occur during the program for each initiative.

d. If budgetary limits are relaxed or tightened, what is the allocation of ASMP funds to the proposed initiatives which best enables the realization of overall force closure objectives? The mathematical programming (MP) model is sensitive to changes in the ASMP budget and is therefore a useful tool for the evaluation of the effect budget variations have on force closure. The suggested funding allocations derived in the proof of principle for both a 60 percent and an 80 percent of budget case are also included in Table 4-1.

1-9. PRINCIPAL FINDINGS

a. Due to its modular approach, the PASMPR methodology is robust. As better sources of data are found, individual modules can be modified if necessary, having a minimal impact on the optimization module. Furthermore, if the required data can be obtained, formulations have been developed that will better address the concerns of decision makers.

c. The capability to model the effect of an initiative's relationship with another initiative has been successfully demonstrated in the solution set.

d. More detailed information is needed regarding the sequential nature of initiatives and the benefits attained by implementation of initiatives.

e. Information is needed that identifies previously made decisions. In other words, which initiatives will be funded based on factors external to this analysis? The answer to this and other such questions needs to be better defined. Less aggregate data is required to make the solution set more meaningful to decision makers.

f. The result of the aggregation of almost 500 initiatives into 37 packages and force structure for two theaters into 15 unit packages is a mixed integer program with 480 noninteger variables, 704 constraints, and 338 integer variables. This configuration runs in only a few minutes on an RS6000 model 590. The implication of this quick turnaround time is that larger, less aggregate data sets are possible, as are responsive, timely replies to the sponsors requests for excursions.

g. The results are limited by the availability and quality of data on the expected benefit of each ASMP initiative or initiative package. Overaggregation of data severely inhibits the ability of the methodology to provide level of tradeoff analyses required by decision makers.

h. Less aggregate data is required to make the solution set more meaningful to decision makers. The required information should most logically come from the installations and units themselves. SAMSONITE, a separate QRA, has been undertaken to determine the availability of this information.

CHAPTER 2

INTRODUCTION

2-1. OVERVIEW

a. The primary purpose of this chapter is to provide a discussion of the background which influenced the conduct of the PASMPR Study. Additionally, this chapter provides a discussion of the limitations and assumptions which impact this effort and a brief overview of the methodology developed and its potential uses.

b. The PASMPR Study was undertaken to provide decision support analysis and to assist Office of the Deputy Chief of Staff for Logistics (ODCSLOG) in developing their ASMP input to the POM. The study focused on the development of a methodology and mathematical model for producing optimal funding streams for the ASMP initiatives.

2-2. BACKGROUND

a. As of the 1990 implementation of the Conventional Forces in Europe (CFE) Agreement with the Soviet Union, the US Army has significantly reduced its forward-deployed force on the European continent. The resulting shift in strategy from containment by large forward-deployed forces to a smaller forward presence implies a heavy reliance on improved mobilization and deployment capability.[1]

b. With the intent to improve and maintain readiness, the Army Strategic Mobility Program is a set of tasks and initiatives designed to ensure the deployment of Army forces in the fastest and most efficient manner possible. The Congressionally-mandated Mobility Requirements Study which is the basis of the ASMP suggests that "to meet the total mobility requirement" as determined in that analysis, the following components are required to achieve an integrated mobility plan:[2]

  (1) Acquisition of additional sealift capacity.

  (2) Acquisition and deployment of PREPO afloat Army combat and combat support equipment.

  (3) Additional surge sealift capability.

  (4) Expansion and modernization of the Ready Reserve Force (RRF).

  (5) Develop new concepts to reduce the cost of required sealift capacity.

  (6) Continue the C-17 program.

(7) Improve components of the continental United States (CONUS) transportation network to include such items as additional heavylift railcars and rail outloading capacity, increased use of containerization, development of a west coast ammunition loading facility, negotiation of additional berthing at loading ports, legislation to ensure required use of ports, and improved readiness of transportation terminal units (TTUs).

c. The ASMP serves as the basis for acquisition of transportation assets and systems, as well as providing for the enhancement of CONUS infrastructure crucial to timely deployability. The program supports, integrates, and builds upon the recommendations of the MRS.

2-3. PROBLEM

a. In order to maintain an emphasis on power projection, it is necessary to have objective decision support tools to assist in determining the relative priorities of the hundreds of initiatives proposed under the ASMP and competing for available resources. Recognizing that the decision maker should have the information available to be able to weigh the advantages of funding one initiative (or package of initiatives) over another, the United States Army Concepts Analysis Agency (CAA) was asked to design a methodology to assist in producing and evaluating alternative procurement plans. CAA's primary objectives in building a tool to support ODCSLOG in the POM building process were to:

(1) Design a mathematical programming model which will find the set of initiatives that is most effective at improving mobilization timelines within budgetary constraints.

(2) Determine the data requirements and coordinate with US Army Logistics Evaluation Agency (USALEA) to provide initiative, unit, and cost data.

(3) Develop a methodology to measure the relative importance of unit packages, recognizing in the model that some unit closures are more critical than others.

(4) Demonstrate the model developed using MRS Southwest Asia (SWA) data provided by USALEA.

(5) Develop the capability to support ODCSLOG, DALO-TZM, in the POM building process.

(6) Provide sensitivity analysis on the effect of budgetary constraints for demonstration data, and POM data, if available.

b. In 1994, USALEA was originally tasked by ODCSLOG (DALO-TSM), the sponsor's representative, to perform an ASMP funding prioritization and decision process study. CAA began working in conjunction with USALEA, directing efforts at developing a methodology that would address the key issues of concern to decision makers. In 1995, at the sponsor's request, a revised study directive was written, with CAA taking the lead and USALEA continuing their efforts developing the project and unit data bases.

2-4. METHODOLOGY. The following critical elements of the PASMPR methodology are described in detail in Chapter 3.

    a. Identify the data needs associated with each ASMP initiative examined and those units to be
affected.

    b. Determine the level of aggregation appropriate for both initiatives and units.

    c. Develop a MIP to serve as the basis of a decision support tool. The resulting model utilizes cost-benefit tradeoff analyses, maximizing the benefit to affected units, subject to constraints on resource allocation, procurement quantities, funding strategies, and required unit arrival times.

    d. Demonstrate the use of the methodology using the 37 initiative packages and 15 unit packages.

2-5. SUMMARY. This chapter presented an overview of the issues that led to the initiation of the PASMPR Study, the objectives of the development effort, and an outline of the methodology. Chapter 3 provides a detailed explanation of the methodology. Chapter 4 describes the demonstration case and details the results of that proof of principle application of the methodology. Special attention may be given to the two appendices which illustrate the ASMP initiatives and unit packages data (see Appendix G and Appendix H).

CHAPTER 3

METHODOLOGY

3-1. GENERAL. This methodology incorporates a Value Added paradigm for optimizing funding strategies across mobilization projects. The approach is modular: each module performs a distinct function. Depending upon the analytical requirements established by the issue to be examined, various tools can be used to perform the required function.
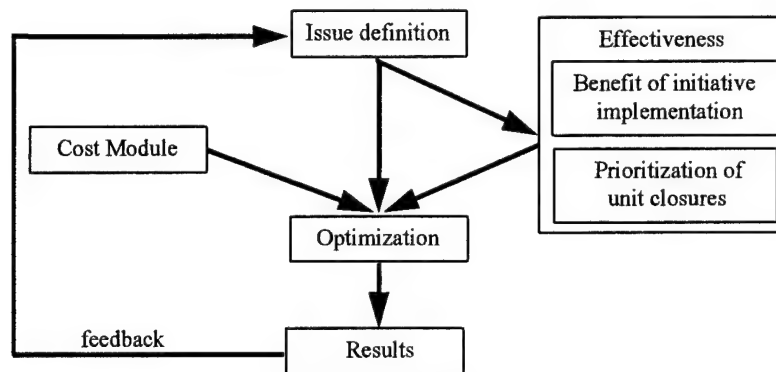
Figure 3-1. Value Added Paradigm for ASMP Resourcing--Flow Diagram

    a. Issue Definition Module. The purpose of the Issue Definition Module is to refine the problem and its associated elements to be studied so that the data collection and analysis efforts can be focused on the questions and issues of interest to decision makers. This process continues for the duration of the study. At a minimum, this process establishes the general context of the study, the allowable level of aggregation of both units and initiatives, as well as the timeframe and scenario of interest. As visualized, issue definition is an ongoing process. Beginning with scoping of the study and culminating in a definition of the issues and questions to be addressed, the feedback loop encourages fine tuning of the process. It is expected that as one question is answered, others will arise. Discussions with the sponsor and representatives from the Military Traffic Management Command Transportation Engineering Agency (MTMC-TEA) and USALEA determined the two major issues of concern to decision makers: the cost of the program and the expected improvement in force closure times.

    (1) Program Costs. Cost estimation for construction, procurement, etc., of the various ASMP projects is not as straightforward a process as one might expect. It is observed that costs are constantly changing and therefore must be tied down at a particular point in time. Construction estimates in particular are highly variable, inevitably increasing as the project date approaches. The primary reason for this is that project designs tend to be tweaked and tuned repeatedly, very often bearing only slight resemblance to the original projects recommended by MTMC-TEA.

(2) **Force Closure Times.** Designed as a set of tasks and initiatives, ASMP projects are intended to ensure the deployment of Army forces in the fastest and most efficient manner possible. It is logical, even necessary, that any analysis of these initiatives intent on prioritizing funding include a measure of the effectiveness for procurement of an initiative. This measure must relate to time, the single most critical deployment shortcoming that the ASMP was undertaken to overcome. If the objective is force projection, an evaluation of the Army's ability to close the force faster than a current benchmark is essential. Although it reflects a timeline based on arrival requirements, the TPFDD used in MRS SWA is reasonably used as the benchmark in this case because the requirement is tempered by the expected availability of units.

b. Cost Module. The Cost Module was developed by USALEA, representing the fixed or marginal cost for each initiative as appropriate. Containers, for example, may be purchased individually, whereas it was further assumed for the purpose of the demonstration case that PREPO afloat must be purchased in its entirety, with the further assumption that the cost would be distributed evenly by year. The model is robust enough to handle a variety of costing conditions once they have been identified. As mentioned in paragraph 3-1a(1), it should be noted that the costs for each type of ASMP initiative varies according to the year in which it was proposed, particularly in the case of infrastructure construction. The costs have not been converted to constant dollars. The data in Table 3-1 is a summary of the more detailed initiative data illustrated in Appendix G.

Table 3-1. Cost Module--Type and Range of Cost by Project Type

ASMP project type	Cost information	Range (in millions)
SEDRES	Fixed cost per exercise	$3
Containers	Average cost per container in container mix for each installation	$.006 - .009
Railcars	Unit cost	$.11
Infrastructure improvements	Fixed cost, varies by initiative	$.3 - 562
Strategic seaport support	Unit cost	$9 - $16
Army watercraft	Unit cost	$.125 - $148.22
Movement control	Fixed cost per receiving unit	$0.359 - $14.6
Container lift kit	Unit cost	$.0078
PREPO afloat	Cost varies as program builds over time	$1,629 (total)

c. Effectiveness Module

(1) Benefits

(a) Derivation. The expected benefit to be achieved from funding for each initiative was determined as a result of the MTMC-TEA ASMP studies as a probability of meeting shortened ASMP mobilization timelines.[5] In many cases, this meant that the entire group of initiatives at a particular installation were necessary to meet the required timelines with a 100 percent probability of success. However, approximately 20 percent of the infrastructure initiatives

were described at a lower level of aggregation. The data in Table 3-2 for an all-rail deployment meeting ASMP standards at Ft. Hood is a good example of the more detailed information available for some of the installations.

Table 3-2. Ft. Hood ASMP Deployment Closure Impact in Terms of Time Saved Resulting from New Deployment Facilities

ASMP Deployment requirement in days	Existing capability in days	Recommended construction projects	Time saved by combined improvements	Estimated probability of completing mission
6 days	9.6 days	4 loading spurs and staging	3.6 days	70-80 %
		3 loading spurs and container handling facility		80-90 %
		4 loading spurs and connector track		90-100 %

The "estimated probability of completing mission" refers to the probability of recovering the 3.6 days required to be shaved from Ft. Hood's current deployment capability. Therefore, their first initiative, with 4 loading spurs, would provide a 70 to 80 percent likelihood of deploying in 6 days. In order to meet the required deployment objective with a 100 percent chance of success, all three initiatives must be funded. For purposes of the prototype, this information was not used. There are many potential problems associated with this type of analysis. First and foremost is the nonlinearity inherent in the probability function. Second, the expected probability never equals 100 percent. Finally, the most limiting factor is that a mere 20 percent of the infrastructure initiatives are defined in this much detail. Not one of the noninfrastructure initiatives is approached in this fashion. It is for these reasons that the prototype model aggregates the benefit information by installation, assuming that all initiatives must be utilized together to achieve the full requirement with 100 percent probability. Therefore, Ft. Hood would gain the full 3.6 days of improvement if and only if all projects at Ft. Hood are completed. These projects are thus packaged together.

(b) Application. An ASMP initiative's effectiveness is thus measured as a function of how much faster it can get each unit (or unit package) that it affects to the theater in question. The actual unit of measure in the demonstration is "brigade days of improvement." For example, in Table 3-3, the 1st Cavalry Division benefits from a hypothetical containerization package (Container pack 2) at Ft. Hood by 21 brigade days. This can occur as 21 days for any one brigade or 7 days for each of three brigades in the division. It is an important advantage of the MIP formulation to recognize that any particular initiative may affect more than one unit, and a specific unit may be affected by more than one initiative. The effect is cumulative in either case unless otherwise specified by constraints. The effectiveness data used in the proof of principle demonstration is provided in Appendix I.

Table 3-3. Effectiveness Module--Notional Sample Benefits

ASMP Initiative	Unit benefit (in brigade days of improvement)		
	1st Cavalry Division	III Corps	13th COSCOM
Container pack 1 *Ft. Hood*	-	-	7
Container pack 2 *Ft. Hood*	21	-	-
Container pack 3 *Ft. Hood*	-	14	-
Railcars *Ft. Hood*	18	12	6
Infrastructure *Ft. Hood*	2.4	2.4	2.4

(c) Global Deployment Analysis Simulation (GDAS) as a Potential Data Source. Due to the problems in the available data discussed in paragraph 3-1c(1)(a), the GDAS model was examined as a potential source of effectiveness data. A description of the GDAS model, a list of the initiatives that can and cannot be modeled, and a brief status on this effort can be found in Appendix E.

(2) Prioritization

(a) Unit Importance. It is obvious on reflection that some units are more important than other units for a specific scenario. It is debatable, however, just which units are most important, and to what degree. Recognizing that the commander in chief (CINC) has put a great deal of time and effort into developing the TPFDD, it is assumed that the sequencing of unit arrivals in a TPFDD represents a good first cut on the priority of units in theater. A methodology was developed which allows the model to utilize the implicit importance hierarchy represented by the TPFDD. Thus, the optimization is able to consider an equal benefit of a more critical unit to provide more value, therefore having greater weight within the scenario.

(b) Risk Assessment. A detailed examination of the effect of unit arrivals in the theater was performed by CAA's Operational Capability Assessments - Southwest Asia Division. Their study, Southwest Asia Risk Analysis[3] (SWA-RA), is the basis of the prioritization scheme. In simplified terms, SWA-RA examines a large number of campaign analyses to draw relationships between the number of brigade-size elements in the theater and the mix of air and ground forces to determine thresholds at which a unit's employment changes the campaign result, i.e., a unit not meeting its designated arrival schedule may result in a draw instead of a win. Figure 3-2 is a conceptual representation of the relationship between quantities of air and ground forces employed at a particular point in time and the warfight result. If, for instance, a hypothetical 10 brigades were needed for a win in the worst case (low Air Force participation), and the 10th brigade did not arrive when scheduled, the predicted result could break the threshold, dropping from win to draw. Furthermore, if a failure of the 11th unit to arrive did not

affect the threshold, then a clear break in the priority of units would be established at that point. Thus, we are able to establish "classes" of units. These classes may be associated with prioritization levels; (1) those units needed to engage the enemy, (2) those needed to maintain a draw, (3) those needed to win, and (4) those in excess of the win--actually exceeding the best case (high Air Force participation) threshold. In an early prototype data set, the above four classes were used. The earliest arrivals demonstrated the highest importance values, fit the classification for prioritization level 1 and were given a weight of .4. Level 2 received a weight of .3, level 3 a weight of .2 and level 4 a weight of .1. The specifics of the TPFDD arrival schedule allowed for this easy breakout in each risk category, with the latest arrivals having the lowest importance values. However, this may not always be the case: the outcome is very scenario-dependent. A risk analysis or similar examination of the data is required for every scenario considered. It was decided by the sponsor that the prototype should utilize evenly weighted units, delaying use of the prioritization scheme until a full unit data base was available.
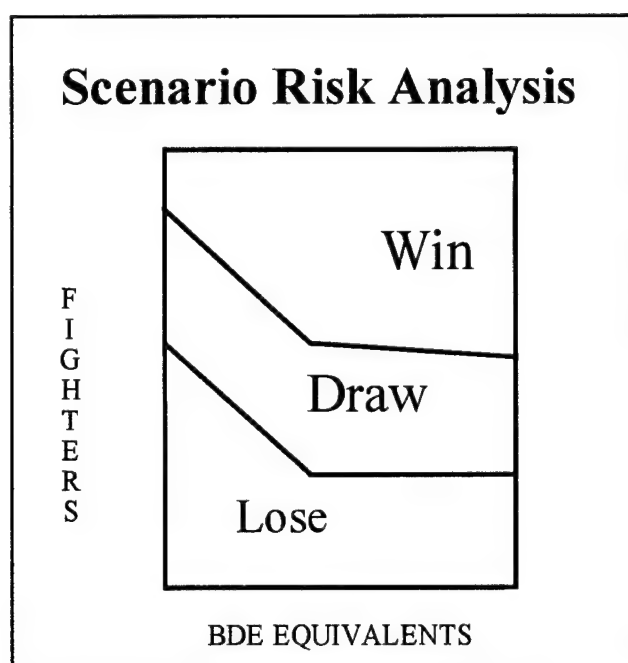
Figure 3-2. Effectiveness Module--Prioritization Thresholds

(c) **Objective Function Coefficients.** The effectiveness module utilizes multi-attribute utility theory to derive importance measures for unit arrivals from the information obtained by the Operational Capability Assessments - Southwest Asia Division. The derived scores then become objective function coefficients for the mathematical optimization. The derivation process also identifies constraints that must be identified in the Optimization Module to assure that the value associated with each unit is linear, on a ratio scale, and additive.

3-2. MODELING ASSUMPTIONS

a. The scenarios and forces used are adequate to test the effectiveness of candidate ASMP initiatives.

b. The unit importance relationships are assumed to reflect decision maker positions as reflected in the TPFDD for the given scenario, further structured by actual simulation results which measure outcomes as a function of arrival schedules. This analysis provides a means of modeling the effect of units with untimely arrivals as well as the importance of particular units in a given scenario.

c. The effectiveness data used will reasonably assess and express the effects of implementing the proposed ASMP initiatives on closure times of Army units, given a specific scenario and force structure. This is a big assumption. At the time of this writing, a time-related measure of the effectiveness for initiatives is unavailable for approximately 80 percent of the data at an appropriate level of aggregation for the decision space. A separate quick reaction analysis (QRA) entitled Strategic Army Mobility: Survey of National Infrastructure, Technology, and Equipment (SAMSONITE) has been undertaken to determine if this data is available or can be readily derived.

d. Aggregation of initiatives is adequate to capture the decision space. This is another critical assumption, necessary in order to test the prototype, but not desirable in the long run. For the prototype, initiatives are aggregated by installation. As will be discussed in the conclusions, aggregation at a per installation level is inappropriate. The decisions to be made do not occur on an installation-by-installation level, but rather on individual ASMP initiatives. Once the determination was made to fund PREPO afloat and the Congressionally-mandated west coast (WC) ammo port, as well as the Charleston, SC PREPO maintenance facility, half of the original $4 billion had been obligated. The remaining $2 billion in the program is not sufficient to fund all proposed projects at the installations. This implies that an installation's requests cannot be funded in their entirety; inter- rather than intrainstallation tradeoff analysis must be performed.

e. Railcars and containers are not procured until infrastructure projects are completed for the same location. This constraint was included due primarily to USALEA concerns that additional railcars would not be needed until CONUS rail improvements are made. It has since been verified that railcars may indeed be purchased prior to the infrastructure rail projects being completed. If possible, cars will be stored on nearby Department of Defense (DOD) facilities. However, storage space will be rented from commercial carriers if needed. It should be noted that the cost of storage was not included in the original cost estimates. This shortcoming needs to be corrected in future analyses.

3-3. OPTIMIZATION MODULE

a. Mixed Integer Linear Programming Model. The final determination of a recommended funding strategy requires the simultaneous consideration of many factors. The two primary

concerns discussed in the Issue Definition Module, cost and timeliness, suggest the use of a cost effectiveness approach, with some measure of timeliness determining the effectiveness of a particular initiative. The mathematical programming model as developed fits the class of capital budgeting formulations.

b. Notation

Indices: i   units
           j   initiatives or projects
           k   years
           m   total number of initiatives
           n   total number of units
           p   funding profile of total number of appropriation types
           l   appropriation type, 1=MCA, 2=OMA, 3=OPA

Variables: x_{jp} $= \begin{cases} 1 \text{ if project j is funded with profile p} \\ 0 \text{ otherwise} \end{cases}$

y_{jkp} = quantity of items bought in project j in year k using profile p

z_i = positive deviation from desired time of closure of unit i,

Sets: P_j = {p:p is an allowable funding profile for project j}

K_p = {k:k is a funding year in profile p}

Data: β_{ij} = difference in time of closure of unit i by procuring project j

α_{ij} = marginal difference in time of closure of unit i by procuring 1 item of project j

w_i = importance weight for unit i

t_{i0} = present closure time of unit i

t_i = required closure time of unit i

B_{kl} = budget for year k and appropriation l

c_{jkpl} = fixed cost of project j, year k, profile p, appropriation l

$\overline{c}_{jkpl}$ = average unit cost of an item of project j, year k, profile p, appropriation l

Y_{jkp}^{min} = minimum procurement quantity of items in project j, year k, profile p

Y_{jkp}^{max} = maximum procurement quantity of items in project j, year k, profile p

Z_i = maximum deviation from required closure time for unit i

R_j^{min} = minimum required quantity of items from project j

R_j^{max} = maximum required quantity of items from project j

c. Preferred Model. In order to achieve deployment goals, it is critical that the Army fund the right set of ASMP projects. But what is the "right" set? We do not set out to determine this fictionally correct set, but rather, within the known constraints, to answer the question: *within available funding levels, which set of initiatives comes closest to meeting closure requirements?* This formulation simultaneously maximizes the benefit received by funding the initiatives while weighting the affected units, ensuring that the units that are required earliest in the theater, or that have the greatest impact in the theater, are given the greatest chance of receiving benefit from funded initiatives. Furthermore, the syntax of this question is important. Proper formulation provides the model with flexibility by not having to ensure that every unit arrives exactly on its closure date. Otherwise, this could be a very restrictive constraint which, given the program dollar limitations, may promote infeasibility. Figure 3-3 presents a detailed description of this formulation.

Minimize: $\quad \displaystyle\sum_{i=1}^{n} W_i Z_i \qquad\qquad\qquad\qquad\qquad\qquad\qquad$ **(obj)**

Subject to: $\quad \displaystyle\sum_{j=1}^{m} (c_{jkpl} x_{jp} + \bar{c}_{jkpl} y_{jkp}) \le B_{kl}, \quad \forall k,l,p \qquad\qquad$ **(1)**

$$\sum_{j=1}^{m}\sum_{p \in P_j} \left(\beta_{ij} x_{jp} + \sum_{k \in K_p} \alpha_{ij} y_{jkp} + t_{i0} - z_i \right) \le t_i, \quad i = 1,\ldots n \quad \textbf{(2)}$$

$$\sum_{p \in P_j} x_{jp} \le 1, \quad \forall j \qquad\qquad\qquad\qquad\qquad\qquad \textbf{(3)}$$

$$Y_{jkp}^{min} x_{jp} \le y_{jkp} \le Y_{jkp}^{max} x_{jp}, \quad \forall j, \; p \in P_j, \; k \in k_p \qquad \textbf{(4)}$$

$$R_j^{min} x_{jp} \le \sum_{k \in K_p} y_{jkp} \le R_j^{max} x_{jp}, \quad \forall j, \; p \in P_j, \qquad \textbf{(5)}$$

$$0 \le z_i \le Z_i, \quad i = 1,\ldots n \qquad\qquad\qquad\qquad\qquad \textbf{(6)}$$

$$x_{jp} \text{ binary}, \quad \forall j, \; p \in P_j \qquad\qquad\qquad\qquad\qquad \textbf{(7)}$$

Figure 3-3. Formulation to Minimize Weighted Unit Lateness

d. Objective Function and Constraint Definition. *The objective function* (obj) is the sum of the weighted deviation from arrival time (lateness) for each unit considered. The deviation, z_i, is derived in constraint (2) below.

(1) *The first constraint* limits the budgetary resources available in each of the POM years to the program dollars available. The model separately controls the three major types of appropriations: Military Construction, Army (MCA), Operation and Maintenance, Army (OMA),

and Other Procurement, Army (OPA). A budget maximum is required for each of these funding types. We allow for both fixed and marginal costs, although at this time, the sponsor does not wish to examine the effect of partial funding packages. Nor is marginal effectiveness data available for many of the relevant initiatives.

(2) *The second constraint* sums the fixed and marginal improvements in closure time, adds that to the current capability, attempts to ensure that the resulting closure time should meet requirements, otherwise measures the deviation from the required closure date. This delta is then minimized in the objective function.

(3) *The third constraint* structures a variety of procurement options, utilizing a lookup matrix with possible procurement strategies for each type of initiative. For example, a container purchase may occur in any of 2 successive years during the 6-year POM cycle, resulting in five possible procurement options for each container initiative. Currently, the procurement options are limited to sequential years, although the model is robust enough to handle a nonsequential requirement if identified. This constraint allows only one procurement operation per initiative. However, it chooses the optimal funding stream from among the choices included in the matrix for that option.

(4) *The fourth constraint* is designed to observe limits in production quantities. There are instances where it is possible to procure variable quantities of an initiative over the 6-year POM cycle. For example, containers or railcars can theoretically be purchased all in 1 year or split over successive years. Therefore, minimum and maximum procurement quantities per year become relevant issues. The variable Y_{jkp} provides upper and lower bounds on yearly production quantities available.

(5) *The fifth constraint* varies from the fourth in that it looks at total requirements for each initiative over the POM. R_j represents the corresponding upper and lower bounds on requirements for deployment initiatives.

(6) *The sixth constraint* requires the deviations in closure time to remain within preset bounds for each unit. For example, suppose the 1st brigade of a given division is scheduled to arrive 7 days earlier than the 3d. If it is deemed desirable to allow the 1st brigade to arrive any time between its scheduled arrival and that of the 3d, Z_i would be set equal to the 7-day difference.

(7) *The seventh constraint* requires that the variable x_{jp}, which equals 1 if a project is funded, is a binary (0-1) variable.

(8) *Additional constraints* that represent the sequential and dependent nature of many of the initiatives are handled through the inclusion of clique constraints. Not only do these additions better define the problem, requiring real relationships to be maintained, they have the added benefit of reducing the size of the feasible region, thus tightening the linear relaxation. Examples of these constraints include such relationships as requiring that all infrastructure improvements at

a particular location are completed before railcar buys for the same location are completed. This assumes that the railcars would not be required if a portion of that incomplete infrastructure is for rail improvements. Another relational constraint is one that captures the requirement for two or more initiatives to be completed simultaneously, or conversely, that two initiatives can be mutually exclusive. A large number of these relationships can be exploited in the model as they become identified. A few examples of such constraints follow:

$$X_{1p} + X_{2p} = 1 \quad \text{(mutually exclusive)}$$

$$X_{1p} - X_{2p} = 0 \quad \text{(fund both or none)}$$

$$X_{1p} - X_{2p} \geq 0 \quad \text{(fund neither, both, or } X_{1p} \text{ only but not } X_{2p} \text{ only)}$$

e. Alternative Model. This formulation is designed to determine the minimum cost expenditure on ASMP initiatives necessary to guarantee that required closure objectives are met. Therefore, the alternative objective function minimizes the fixed and marginal cost of funding an initiative. Unlike the preferred formulation, no variance from the closure objective is allowed; thus the variables z_i and Z_i are no longer needed. Although the model is minimizing cost, it will cost more in ASMP program dollars to ensure that the Army can absolutely meet the timeline. Therefore, the budget ceiling is lifted, removing a possible impediment to feasibility. Figure 3-4 presents a detailed description of this formulation.

$$\textbf{Minimize:} \quad \sum_{l=1}^{q} \sum_{j=1}^{m} \sum_{k \in K_p} \sum_{p \in P_j} (c_{jkpl} x_{jp} + \bar{c}_{jkpl} y_{jkp})$$

$$\textbf{Subject to:} \quad \sum_{j=1}^{m} \sum_{p \in P_j} (\beta_{ij} x_{jp} + \sum_{k \in K_p} \alpha_{ij} y_{jkp} + t_{i0}) \leq t_i, \quad i = 1,...n)$$

$$\sum_{p \in P_j} x_{jp} \leq 1, \quad \forall j$$

$$Y^{min}_{jkp} x_{jp} \leq y_{jkp} \leq Y^{max}_{jkp} x_{jp}, \quad \forall j, \ p \in P_j, \ k \in k_p$$

$$R^{min}_j x_{jp} \leq \sum_{k \in K_p} y_{jkp} \leq R^{max}_j x_{jp}, \quad \forall j, \ p \in P_j,$$

$$x_{jp} \text{ binary}, \quad \forall j, \ p \in P_j$$

Figure 3-4. Formulation to Minimize Cost of Meeting Closure Time

f. Prototype Model. The prototype model was designed to accommodate aggregate effectiveness data due to the unavailability of effectiveness data for each initiative. With the funding impact measured on an installation-by-installation basis, it is no longer reasonable to look at the lateness of individual units, but rather the cumulative improvement in arrival times. This

formulation addresses a slightly different question than in the original formulation: *within available funding, what set of initiatives results in the greatest time savings across all units?*

g. Prototype Variations from Preferred Model. The original formulation gets at the crux of the main issue--planners do not want units to arrive late. The prototype model does not address this issue well for two reasons. First, the functionally allowable lateness of some units is ignored. If two units were weighted equally, one with zero tolerance for lateness, and the other with a 7-day tolerance and all other data equivalent, the model would be indifferent as to which unit receives improved deployment initiatives. Perhaps a more important concern is the fact that this formulation can allow a particular unit to overachieve, i.e., to arrive early. It is possible that the dollars spent to achieve this excess in capability could have been better spent on initiatives that would reduce the lateness of other units. However, the model seeks the greatest absolute improvement and is not concerned in this instance about late vs early. Second, the fact that early arrivers can crowd the ports and severely tax the intratheater transportation network is another disadvantage of the prototype formulation. Figure 3-5 presents a detailed description of this formulation. This formulation is used only for illustrative purposes with the intention of demonstrating the usefulness of this type of analytical tool. It is a starting point for future development as both the sponsor and CAA attempt to acquire the data needed to populate the preferred model described in paragraph 3-3c above. The results of this demonstration using the prototype model are detailed in Chapter 4.

Maximize:
$$\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{p\in P_j}(\beta_{ij}w_i x_{jp} + \sum_{k\in K}\alpha_{ij}w_i y_{jkp})$$

Subject to:
$$\sum_{j=1}^{m}(c_{jkpl}x_{jp} + \bar{c}_{jkpl}y_{jkp}) \le B_{kl}, \quad \forall k,l,p$$

$$\sum_{p\in P_j}x_{jp}\le 1, \quad \forall j$$

$$Y_{jkp}^{min}x_{jp} \le y_{jkp} \le Y_{jkp}^{max}x_{jp}, \quad \forall j,\ p\in p_j,\ k\in k_p$$

$$R_j^{min}x_{jp} \le \sum_{k\in K_p}y_{jkp} \le R_j^{max}x_{jp}, \quad \forall j,\ p\in p_j,$$

$$x_{jp}\ \text{binary}, \quad \forall j,\ p\in P_j$$

Figure 3-5. Formulation to Maximize the Weighted Time Improvement

CHAPTER 4

PROTOTYPE RESULTS

4-1. OVERVIEW. The PASMPR Study was undertaken to provide decision support analysis and to assist ODCSLOG in developing their ASMP input to the POM. The study focuses on the development of a methodology and mathematical model for producing optimal funding streams for the ASMP initiatives. Chapter 2 provides the background information which framed this analysis and which comprises the guiding as well as limiting factors in model development. Chapter 3 is a detailed discussion of the proposed methodology and resulting models.

4-2. PURPOSE. The primary purpose of this chapter is to provide a discussion on the possible uses for and the implementation of the PASMPR methodology. Optimal funding strategies for various levels of funding were developed based on the best available data. This chapter further provides a discussion of the limitations in the use of this methodology due to significant aggregation in the available data.

4-3. RESULTS. This analysis has been performed at several funding levels, making the assumption that expected funding levels are rarely stable and seldom as expected. The intention is to vary the funding parameter and provide a set of alternative funding streams for each variation. This method allows decision makers to choose a likely budget level to evaluate the resulting ASMP funding stream. For purposes of this prototype, the budgetary limit for the base case is equivalent to 100 percent of the total cost of all initiatives. This total was then distributed evenly among the 6 years considered. Obviously, in future usage of the model, it would be preferable to use actual yearly MCA, OMA, and OPA projections. Unfortunately, such projections for ASMP were not available in time to execute the prototype. Two funding alternatives, 80 and 60 percent of the base case, are provided to demonstrate the variances that can occur in results at reduced funding levels. These two alternatives demonstrate the most meaningful variances and are deemed sufficient for illustrative purposes of the prototype model.

  a. Suggested Funding Profiles. An advantage of the approach taken in this methodology is that the model is allowed to choose the most cost effective funding profile for each initiative while maintaining the identity of the type of allocation involved (MCA, OMA or OPA). As we reduce the amount of funding available, it is common for an initiatives funding profile, i.e., the years in which it is funded, to vary. As illustrated in the prototype results (Table 4-1), several initiatives with large costs are found to "slip" in the solution, delaying their procurement by 1 or more years. This is the case with the OPA-funded railcars for Ft. Stewart. As total program dollars available were decreased to 80 percent of the original, the funding profile was actually accelerated by 1 year. Then, with an additional 20 percent decrease in OPA funds available, the Ft. Stewart railcar buy was pushed back 2 years from the base case profile. Also of interest at the 60 percent level is that the railcars scheduled for Ft. Hood were no longer competitive in the solution due to their high total cost and were thus eliminated. Although the base case represents a fully funded (100 percent) program, the funds were evenly distributed over the 6 year period. Therefore, in any given year, funds may not be available to fully fund all programs.

b. Alternative Solution Sets. Another possible outcome of reduced funding is that some initiatives are no longer affordable at 100 percent of their stated implementation cost and leave the solution set. As a result, other initiatives may actually rise in the solution set, entering the solution for the first time, or, more commonly, obtain funding over an earlier time period as other initiatives slip or leave the set altogether. This can be seen in Table 4-1 below. When PREPO afloat is no longer funded at its full implementation (as in the 80 percent case), a large quantity of funding of a particular procurement type (OMA) is now available to be spent on other initiatives with that type of procurement. Therefore, other initiatives of the same procurement type that were previously precluded now have room to enter the solution: containerization for the sustainment base, and OMA infrastructure for the miscellaneous category "other."

Table 4-1. Prototype Generated Alternative Funding Profiles for ASMP Initiatives, 1996 - 2001

Initiatives	Fully funded		80% Funded		60% Funded	
	Years	6-year cost	Years	6-year cost	Years	6-year cost
SEDRES Savannah	96-01	$6 Mil	96-01	$6 Mil	96-01	$6 Mil
SEDRES Beaumont	96-01	9	96-01	9	96-01	9
SEDRES Jacksonville	96-01	6	96-01	6	96-01	6
Containers, Ft. Hood, 13 COSCOM	2000	2.054	2001	2.054	2001	2.054
Containers, Ft. Hood, 1 Cav	2000	3.352	2001	3.352	2001	3.352
Containers, Ft. Hood, III Corps	2000	1.915	2001	1.915	2001	1.915
Containers, Ft. Bragg, XVIII Corps	99	2.67	99	2.67	98	2.67
Containers, Ft. Bragg, 82 Abn	99	2.092	2000	2.092	99	2.092
Containers, Ft. Bragg, 1 COSCOM	99	4.988	2001	4.988	99	4.988
Containers, Ft. Stewart, 24 Mech	2001	9.338	98	9.338	99	9.338
Containers, Ft. Campbell, 101 AASLT	98	3.181	98	3.181	98	3.181
Containers, Ft. Bliss, 3 ACR	99	2.745	99	2.745	99	2.745
Containers, Spt and Sustainment Base	-	0	2000	18.576	97	18.576
Containers, Other Divisions	96	11.648	99	11.648	99	11.648
Containers, USMC	97	2.76	96	2.76	96	2.76
Railcars, Ft. Stewart	98-99	13.9	97-98	13.9	2000-01	13.9
Railcars, Ft. Benning	98-99	15.2	98-99	15.2	2000-01	15.2
Railcars, Ft. Hood	2000-01	47.9	2000-01	47.9	-	0
Railcars, Ft. Campbell	97-98	21.89	98-99	21.89	98-99	21.89
Railcars, Ft. Bliss	-	0	-	0	-	0
Railcars, USMC	96-97	3.2	96-97	3.2	96-97	3.2
Railcars, AAP and Depots	96-97	21.5	96-97	21.5	96-97	21.5
OMA Infrastructure, Ft. Bliss	-	0	-	0	-	0
OMA Infrastructure, Ft. Campbell	-	0	-	0	-	0
OMA Infrastructure, Other	-	0	97-98	22	97-98	22
MCA Infrastructure, Ft. Bliss	97-99	96.4	97-99	96.4	97-99	96.4
MCA Infrastructure, Ft. Campbell	96-98	21	96-98	21	96-98	21
MCA Infrastructure, Ft. Stewart	97-99	36.5	96-98	36.5	97-99	36.5
MCA Infrastructure, Ft. Benning	97-99	42.6	96-98	42.6	96-98	42.6
MCA Infrastructure, Ft. Bragg	97-99	51.5	97-99	51.5	96-98	51.5
MCA Infrastructure, Ft. Hood	96-98	87.3	96-98	87.3	99-01	87.3
MCA Infrastructure, Charleston	98-2000	35.1	97-99	35.1	99-01	35.1
MCA Infrastructure, WC Ammo Port	98-2000	55	97-99	55	97-99	55
MCA Infrastructure, Other	-	0	-	0	-	0
PREPO Afloat, Ship Lease/Readiness	96-01	1629	-	0	-	0
PREPO Outload Facility Charleston	96-01	56.7	96-01	56.7	96-01	56.7
PREPO Outload Facility WC Ammo Port	96-01	43.3	96-01	43.3	96-01	43.3
Total cost		2345.733		757.309		709.409
Obj value (total benefit)	227.98		226.98		190.98	

c. Effect of Clique Constraints on Profiles. Since the railcar procurements are the only use of OPA funds, they provide the clearest demonstration of the effect a particular initiative's relationship with another initiative has on the solution set. The most typical relationships modeled include simultaneous or sequential timing, and mutually exclusive inclusion in the solution set. For example, as the budget decreases to the 80 percent level, the same set of railcar initiatives is funded; however, the profiles vary. The primary reason is that the infrastructure initiatives, to which the railcar initiatives are tied, also varied. Railcar procurement is constrained to occur in the same or subsequent years as infrastructure initiatives at identical locations. Therefore, as infrastructure at Ft. Stewart becomes funded in earlier years at the 80 percent level, railcars at Ft. Stewart may also be funded earlier.

d. Effect of Weighting Objective Coefficients. The objective function utilized for the prototype model maximizes the weighted fixed and marginal benefit realized from procurement of a particular initiative, where w_i is the importance weight for unit i, and β_{ij} and α_{ij} represent the fixed and marginal benefits, respectively, for unit i and project j (see paragraph 3-3g).

$$\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{p\in P_j} (\beta_{ij}w_i x_{jp} + \sum_{k\in K_p} \alpha_{ij}w_i y_{jkp})$$

As part of this analysis, the effect of changes in the importance weights was evaluated to assure they behaved functionally as anticipated. Indeed, all else being equal, as higher weights were applied to units, their associated initiatives were funded, and often funded earlier. Conversely, when a weight was decreased to zero, i.e., indifferent to the lateness of that unit, the affected initiatives did not appear in the solution set. This interaction between the objective function and constraints occurred as planned. The methodology for developing the unit weights is discussed in paragraph 3-1c(2)(b). The values used for both unit weights and benefits are located in Appendix H and Appendix I, respectively. For purposes of the prototype, units were aggregated into 15 packages, a level comparable to the installation perspective used for initiatives (see paragraph 4-4 below). For this reason, the data used is more notional than useful beyond the scope of this proof of principle.

e. Marginal Value Analysis. Due to the nature of mixed integer programming, it is not possible to evaluate the marginal values traditionally associated with variables and constraints in a strict linear programming application. Once one iteratively branches away from the linear relaxation, the marginal values, shadow costs, no longer exist.

4-4. EFFECTS OF AGGREGATION

a. Aggregated Units. Rather than the brigade size units originally anticipated, units were aggregated into unit packages, with package elements varying in size from brigade to division to COSCOM. Although the 15 packages represented in Figure 4-1 are currently being modeled, the model is not limited to that level of aggregation, with 30 to 40 packages seen as a likely range for

the future. Comparing an entire corps and a brigade, especially when applying weights to those units, is less than desirable. However, USALEA was not able to provide the unit data needed in time for execution of the prototype. By necessity, some degree of aggregation is necessary. Should the smallest unit considered be a company, brigade, or battalion? After much discussion with the sponsor and USALEA, it was determined that units would continue to be packaged, with an emphasis on trying to evaluate benefits to brigade-sized units, both combat and combat support/combat service support (CS/CSS) where possible.

Lead Bde, 82d Airborne	24th Mechanized Div	2d Bde, 101st
2d Bde, 82d Airborne	3d ACR	Sep Bde, Heavy
XVIII CORPS	1st Cavalry Div	Sustainment Base
1 COSCOM	III CORPS	Other US Forces
1st Bde, 101st	13th COSCOM	General Readiness Forces

Figure 4-1. Aggregate Unit Packages

   b. Initiatives. There are over 500 initiatives in the ASMP currently aggregated into 37 packages, looking primarily at fort-to-port initiatives, with a few exceptions. Figure 4-2 displays the aggregate initiatives and illustrates actual rollups for two of those aggregates.

SEDRES Savannah
SEDRES Beaumont
SEDRES Jackson
Containers, Ft. Hood, 13 COSCOM
Containers, Ft. Hood, 1 Cav
Containers, Ft. Hood, III Corps
Containers, Ft. Bragg, XVIII Corps
Containers, Ft. Bragg, 82 Abn
Containers, Ft. Bragg, 1 COSCOM
Containers, Ft. Stewart, 24 Mech
Containers, Ft. Campbell, 101 ASSLT
Containers, Ft. Bliss, 3 ACR
Containers, Spt and Sustainment Base
Containers, Other Divisions
Containers, USMC
Railcars, Ft. Stewart
Railcars, Ft. Benning
Railcars, Ft. Hood
Railcars, Ft. Campbell
Railcars, Ft. Bliss
Railcars, USMC
Railcars, AAP and Depots
OMA Infrastructure, Ft. Bliss
OMA Infrastructure, Ft. Campbell
OMA Infrastructure, Other
MCA Infrastructure, Ft. Bliss
MCA Infrastructure, Ft. Campbell
MCA Infrastructure, Ft. Stewart
MCA Infrastructure, Ft. Benning
MCA Infrastructure, Ft. Bragg
MCA Infrastructure, Ft. Hood
MCA Infrastructure, Charleston
MCA Infrastructure, WC Ammo Port
MCA Infrastructure, Other
PREPO Afloat, Ship Lease/ Readiness
PREPO Outload Facility Charleston
PREPO Outload Facility WC Ammo Port

Ft. Stewart
Rail Pass Track
DAAG Facilities
Rail Marshalling Yard
Expand Ammo Storage Access
General Purpose Warehouse
Green Ramp Staging Area
Track, Ramp, Turnout

Ft. Hood
Extend AFB
Upgrade Runway
Upgrade AF Ramp
Contingency Stock Warehouse
4 Rail spurs, Cont Fac (P1)
3 Rail spurs, Stage Area (P2)
4 Rail spurs, Track (P3)
AAF Upgrade

Figure 4-2. Aggregate ASMP Initiatives

c. Efficacy of Aggregated Data. In accord with one of the key assumptions of this study, the effectiveness data is expected to reasonably assess and express the effects of implementing the proposed ASMP initiatives on closure times of Army units. Unfortunately, the data available at the time required for execution of the prototype (a compilation of the MTMC-TEA ASMP studies) considered the initiatives on most installations as an aggregate whole, as seen in the Ft. Stewart and Ft. Hood examples above. Due to the large numbers of initiatives grouped together in the effectiveness data, the type of analysis possible is severely limited. Tradeoffs exist only as installation-by-installation decisions and are not possible at the individual initiative level. Rather than having the capability of answering the question, *should the Army fund railcars at Ft. Hood or improve their staging capability or build phase I of their railyard upgrade or...?* the capability is limited to addressing the question, *should we fund railcars or all infrastructure at Ft. Hood?* Yet another complicating factor is the large numbers of units affected identically by those initiatives--all units passing through those installations! Not all units will deploy using the same mode of transport, yet all are affected to the same degree by each aggregate of initiatives. These weaknesses in the data need to be addressed before meaningful tradeoff analysis can occur.

4-5. PROTOTYPE LESSONS LEARNED

a. A capital budgeting MIP can be used to evaluate the prioritization and funding stream for ASMP initiatives.

b. To be successful, aggregation of initiatives should be held to a minimum.

c. If required, aggregation should occur according to functional, mission-oriented categories, i.e., airfields, warehousing, rail upgrades, etc.

d. Due to the vast array of units that could be considered, including reserve and guard units, future work should continue to utilize unit packaging, with the emphasis on brigade-sized combat and CS/CSS unit rollups.

e. The short run time of the prototype model, less than 4 minutes, implies larger problems are possible.

APPENDIX A

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APPENDIX B

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13.0 JAN. 1995

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DIRECTOR, U.S. ARMY CONCEPTS ANALYSIS AGENCY, 8120 WOODMONT
   AVENUE, BETHESDA, MD 20814-2797

COMMANDER, U.S. ARMY LOGISTICS EVALUATION AGENCY,
   NEW CUMBERLAND, PA 17070-5007

COMMANDER, MILITARY TRAFFIC MANAGEMENT COMMAND, ATTN: MTPL,
   5611 COLUMBIA PIKE, FALLS CHURCH, VA 22041-5050

SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

1. References:

    a. Memorandum, HQDA (DALO-TSM), 21 Dec 93, subject: Routine
Task: Prioritization of Army Strategic Mobility Program (ASMP)
Resources (Encl 1).

    b. Memorandum, HQDA (DALO-TSM), 11 May 94, SAB (Encl 2).

    c. In-Process Review (IPR) meeting, 2 Sep 94.

2. Reference 1a tasked the U.S. Army Logistics Evaluation Agency
(USALEA) to oversee the development of a decision support system
for the prioritization of ASMP resources. Reference 1b requested
U.S. Army Concepts Analysis Agency (CAA) develop, validate, and
demonstrate initial application of an ASMP Decision Support Model
to assist in the allocation of ASMP funding resources in an
optimal manner. Reference 1c was an IPR at which study status,
strategy startup, and future direction of study were discussed.

3. This memorandum supersedes the original study directive and
tasker to reflect changes in responsibilities that emerged
following reference 1c.

DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

4. STUDY DIRECTIVE: Request that the U.S. Army Concepts
Analysis Agency (CAA) develop, validate, and demonstrate initial
application of an ASMP Decision Support Model to assist in the
allocation of ASMP funding resources in an optimal manner. This
directive establishes objectives and provides guidance for the
conduct of the required study.

5. BACKGROUND: The Department of the Army has allocated money
for short- and long-term improvements in the Army's strategic
mobility capabilities based on requirements delineated in the
ASMP. With an emphasis on power projection, it is necessary to
have objective decision support tools to assist in determining
relative priorities of initiatives proposed under the ASMP that
are competing for available resources. Support tools would
assist in resource allocation when either funding increases or
decrements occur.

6. STUDY SPONSORS AND STUDY DIRECTOR:

   a. The Director of Transportation, Energy and Troop Support,
Office of the Deputy Chief of Staff for Logistics (DALO-TSZ) is
the study sponsor. The study sponsor's representatives are
Mr. Roy Wallace and Mrs. Cecilia Fox (DALO-TSM).

   b. USALEA will collaborate with CAA in the ASMP Decision
Support Model Study covered by this directive. USALEA action
officers are Mr. Gene Markel and Mrs. Irene Mangle.

   c. Military Traffic Management Command (MTMC) will provide
analytical results and data from completed ASMP Infrastructure
Analyses and other published data as requested in support of the
prioritization model project and future POM development.. MTMC
contacts are Ms. Ursula Loy, MTPL, and Mr. Tom Lefebure, MTMC
Transportation Engineering Agency (MTMCTEA).

   d. The Study Director for CAA is Ms. Patricia Murphy.

7. STUDY AGENCY: U.S. Army Concepts Analysis Agency.

8. TERMS OF REFERENCE:

   a. Purpose. The purpose of this study is to develop,
validate, and demonstrate application of an analytic
methodology to assist in managing defined ASMP requirements,
proposed enhancements, and available resources in a cost

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DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

effective way. The resulting mathematical model and analytic
methodology will identify optimal ASMP investment strategies,
maximizing the 'value added' from proposed ASMP initiatives to
improve the Army's posture for achieving anticipated strategic
deployment objectives within applicable resource constraints.
The ultimate purpose is to aid in the preparation of the
Program Objective Memorandum (POM) and budget decision
processes.

    b. Definitions:

        (1) <u>Value added</u> is the marginal return on investment,
based on the effectiveness of various initiatives proposed
under ASMP to improve some aspect of strategic mobility,
relative to the costs of the initiatives.

        (2) An <u>ASMP initiative</u> is a defined infrastructure
improvement, resource acquisition, capability enhancement,
or other similar action that uses funding resources to
enhance deployability of a specified Army force element.

    c. Scope:

        (1) Baseline program is President's Budget Fiscal Year
(FY) 95 and the Program Objective Memorandum (POM) (FY 96), or
the latest appropriate funding document.

        (2) The analysis will examine the funding stream
associated with ASMP.

        (3) Approximately 500 ASMP initiatives, representing
large dollar amounts in current and future projects, will be
included. Inclusion of any particular initiative is subject to
the ability to effectively represent that initiative in terms of
data and modeling capability. ASMP initiatives will be
aggregated as necessary and appropriate.

        (4) Scenarios and forces. The scenario and force
structure employed for the draft Total Army Analysis (TAA) 2003
(TAA03) will be used for initial model development and validation
purposes. The end product model and methodology will be flexible
to accommodate varying scenarios and force structures.

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DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

d. Proposed Methodology. A mathematical programming model
will be developed based upon CAA's Value Added Analysis paradigm.
The model will be used to analyze candidate ASMP initiatives with
respect to costs and benefits, and will generate recommendations
regarding funding priorities and funding levels for proposed ASMP
initiatives.

e. Objectives:

(1) Identify objectives, capabilities, and requirements
to perform subject analysis. In particular, develop a
mathematical modeling formulation and determine data requirements
to populate the resulting model.

(2) Implement the modeling formulation. Test with
notional data, making corrections, improvements, and modifi-
cations as necessary. This effort will be in collaboration with
USALEA and will be performed concurrently with USALEA data
collection effort and MTMCTEA furnishing analytical results and
data from completed ASMP Infrastructure Analyses. CAA will
ensure consistency between data and model.

(3) Test and continue the development effort using the
data collected by USALEA and analytical results and data from
completed ASMP Infrastructure Analyses furnished by MTMCTEA.

(4) Conduct a demonstration of the refined model. This
will use the best available data obtained from authoritative
sources. Results of this analysis will form the Base Case for
this study.

(5) Support DALO-TSM in the POM building process as
necessary.

f. Timeframe. Initial use is for fiscal obligation
analysis timeframe POM period FY 98 through FY 03.

g. Limitations. The optimization model will initially be
installed at CAA because the hardware and software required are
currently available only at CAA. CAA will provide the developed
capability, both data and tools, to the sponsors, USALEA, and
MTMCTEA for their use in internal analyses.

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DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

h. Assumptions:

(1) The scenarios and forces used in the study will be
adequate to measure the effectiveness of candidate ASMP
initiatives.

(2) The measures of effectiveness (MOE) used for
purposes of this study accurately assess and express the effects
of implementing the proposed ASMP initiatives on the closure
times of Army units.

i. Essential Elements of Analysis (EEA):

(1) Does the proposed mathematical programming
formulation satisfy the analytic requirements of this study at
the required level of sensitivity?

(2) Taking force closure times as the primary MOE in
determining effectiveness of the candidate ASMP initiatives, what
allocation of available ASMP funds to the proposed initiatives
best enables the realization of overall force closure objectives?

(3) What ASMP initiatives, in what relative order of
priority, are recommended in the Demonstration Case for
procurement in the Army POM?

9. RESPONSIBILITIES:

a. ODCSLOG (DALO-TSM) will:

(1) Provide a study sponsor representative and study
guidance.

(2) Assist in data collection required to conduct the
study.

b. USALEA will:

(1) Provide a study representative.

(2) Collaborate in the development of the funding
prioritization model, primarily in an advisory or consultive
capacity.

(3) Acquire and provide existing data from sources for
the performance of the study, specifically:

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DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

      (a)   In the short-term, collect and provide data, in the
form of the difference in unit deployment days as effected by
each current ASMP initiative, from subject matter experts.

      (b)   In the long-term, collect and provide data, when
available, from existing models in the same format described
in 9b(3)(a).

      (c)   Provide methodology of conversion of data from
Force to model for inclusion in model development.

   c.   MTMCTEA will:

      (1)   Provide a study representative.

      (2)   Provide analytical results and data for completed
ASMP Infrastructure Analyses as input to the prioritization model
development and future POM development.

   d.   CAA will:

      (1)   Conduct the ASMP funding prioritization modeling
study and analysis.

      (2)   Designate a study director and provide the study
team.

      (3)   Provide periodic in-process reviews (IPR) as
requested by the study sponsors.

10.   REFERENCES: The Army Program Value Analysis (90-97)
(CAA-SR-91-9) and Army Program Value Analysis (94-99)
(CAA-SR-92-10) Reports provide the basis for the methodology and
approach to this study.   Other references include the President's
FY 95 Budget.

11.   ADMINISTRATION:

   a.   Support:

      (1)   Funds for travel and/or per diem will be provided by
the parent organizations of the individuals traveling.

      (2)   ADP support will be provided by CAA.

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DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

> (3) Secretarial support, reports, and publication will
be provided by CAA.

> b. Key Milestones and Milestone Schedule.

```
Began Model Development ............................ 1 Feb 94
Completed Prototype Model ......................... 14 Feb 94
Completed Prototype Testing ....................... 28 Mar 94
Full Scale Development Began ...................... 1 Apr 94
Completed Base Case Demonstration ................. 2 Sep 94
Complete Data Collection .......................... 15 Jan 95
Model Demonstration/IPR ........................... 15 Feb 95
Preparation Complete to Support POM Development... 1 May 95
Technical Effort Completed/Final IPR ............. 30 Jun 95
Documentation Completed and Delivered ............ 30 Jul 95
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> c. Control Procedure. The study sponsors' representatives
will coordinate and communicate within the HQDA staff and between
the ARSTAF and the study agency.

2 Encls

MARIO F. MONTERO, JR.
Brigadier General, GS
Director of Transportation,
Energy and Troop Support

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DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, DC 20310-0500

DALO-TSM

2 1 DEC 1993

MEMORANDUM THRU ASSISTANT DEPUTY CHIEF OF STAFF FOR LOGISTICS

FOR COMMANDER, U.S. ARMY LOGISTICS EVALUATION AGENCY,
    NEW CUMBERLAND, PA 17070-5007

SUBJECT: Routine Task: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

1. Request the following routine task be accomplished by the
U.S. Army Logistics Evaluation Agency (USALEA):

    a. Proposed title: ASMP Resourcing Prioritization Process.

    b. Description: USALEA will oversee the development and
institutionalization of a decision support model and process to
determine how best to invest ASMP incremental funding (or how
best to absorb funding decrements) to maximize total system
throughput in a contingency theater deployment.

    c. Purpose: To enable the Army to manage its ASMP funding
requirements and resources in a cost effective way. This will
aid the program objective memorandum (POM) and budget decision
processes.

2. Background: The Department of the Army has allocated money
for short- and long-term improvements of strategic mobility
capabilities based on requirements delineated in the ASMP. With
an emphasis on power projection, it is necessary to have
.objective decision support tools to assist in determining
relative priorities of projects competing for available funds,
and to assist in determining how best to allocate funding
increments or decrements as they occur.

3. Benefits: This effort will assist the Army in making cost-
effective decisions regarding the allocation of available funding
resources to defined ASMP tasks and initiatives. If funding
reductions are imposed, it also will assist in determining how
they should be distributed so as to minimize negative effects on
strategic mobility. The net result is the development of
capability and structure to ensure deployment of Army forces in
the fastest and most efficient manner possible.

DALO-TSM
SUBJECT: Routine Task: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

4. Technical approach:

a. Phase I: Identify objectives and requirements to be met
by the proposed funding prioritization process. Determine
factors that need to be considered, and develop a conceptual
overview of the capability needed. Survey and review potentially
relevant existing models and capabilities. Based upon the
conceptual overview, an assessment of models already available,
and in collaboration with the U.S. Army Concepts Analysis Agency
(USACAA), define the requirements and conceptual design of a
decision process model to assist in determining optimal
investments of ASMP funds. Begin prototype development.

b. Phase II: Employ the rationale and prototype elements of
the conceptual process model to assist in prioritizing ASMP
initiatives for the Army's next POM build. Review and evaluate
the conceptual prototype application, and incorporate lessons
learned to revise/improve the concept and design as needed.

c. Phase III: Based upon results and recommendations from
Phases I and II, provide general oversight of combined LEA and
CAA efforts for full scale development of the decision model and
process.

d. Phase IV: Use developed capability to support future POM
processes as required.

5. Project Requirement:

a. Proposed task completion dates:

    (1) Phase   I: Research, project definition,
                     and concept development.   - Jan 1994

    (2) Phase II: Support POM build.   - Apr 1994
                     Review and evaluate POM experience
                     for lessons learned.   - Jun 1994

    (3) Phase III: Full scale model development. - Nov 1994

    (4) Phase IV: Ongoing support of future POMs.

b. In-process reviews with the Assistant Director for
Transportation.

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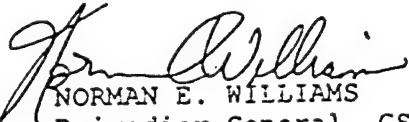
DALO-TSM
SUBJECT: Routine Task: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

6. Administrative details:

   a. ODCSLOG (DALO-TSM) action officers: Mrs. Cecilia Fox,
DSN 224-6610, and Mr. Roy Wallace, DSN 224-6620.

   b. USALEA action officers: Mr. Gene Markel, DSN 977-7629,
and Mrs. Irene Mangle, DSN 977-6901.

   c. USACAA action officers: Mr. Steve Siegel, DSN 295-5289,
and LTC Andy Loerch, DSN 295-1546.

NORMAN E. WILLIAMS
Brigadier General, GS
Director of Transportation,
Energy and Troop Support

3

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DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
500 ARMY PENTAGON
WASHINGTON, DC 20310-0500

11 MAY 1994

DALO-TSM

Robison 17 May 94

MEMORANDUM THRU

DEPUTY CHIEF OF STAFF FOR LOGISTICS, 500 ARMY PENTAGON,
WASHINGTON, DC 20310-0500

F DIRECTOR OF THE ARMY STAFF, 202 ARMY PENTAGON, WASHINGTON, *17 May 94*
DC 20310-0202 *MICHAEL B. WILSON, LTC, GS, A*

FOR DIRECTOR, U.S. ARMY CONCEPTS ANALYSIS AGENCY, 8120 WOODMONT
AVENUE, BETHESDA, MD 20814-2797

SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

1. STUDY DIRECTIVE: Request that the U.S. Army Concepts
Analysis Agency (CAA) develop, validate, and demonstrate initial
application of an ASMP Decision Support Model to assist in the
allocation of ASMP funding resources in an optimal manner. This
directive establishes objectives and provides guidance for the
conduct of the required study.

2. BACKGROUND: The Department of the Army has allocated money
for short- and long-term improvements in the Army's strategic
mobility capabilities based on requirements delineated in the
ASMP. With an emphasis on power projection, it is necessary to
have objective decision support tools to assist in determining
relative priorities of initiatives proposed under the ASMP and
competing for available resources as funding increments or
decrements occur. The U.S. Army Logistics Evaluation Agency
(USALEA) has been tasked by this office to perform an ASMP
funding prioritization and decision process study. This
directive tasks CAA to develop and implement a mathematical
programming methodology to perform cost-benefit and trade-off
analyses needed in support of the USALEA study plan.

3. STUDY SPONSORS AND STUDY DIRECTOR:

a. The Director of Transportation, Energy and Troop Support,
Office of the Deputy Chief of Staff for Logistics (DALO-TSZ) is
the study sponsor.

b. USALEA will perform the parent ASMP Funding
Prioritization Study and will collaborate with CAA in the
ASMP Decision Support Model Study covered by this directive.

DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

c. The study sponsor's representatives are Mr. Roy Wallace
and Ms. Cecelia Fox (DALO-TSM).

d. USALEA action officers for this study and the parent
USALEA study are Mr. Gene Markel and Mrs. Irene Mangle.

e. The Study Director for CAA is Ms. Patricia Murphy.

4. STUDY AGENCY: U.S. Army Concepts Analysis Agency.

5. TERMS OF REFERENCE:

a. Purpose. The purpose of this study is to develop,
validate, and demonstrate application of an analytic
methodology to assist in managing defined ASMP requirements,
proposed enhancements, and available resources in a cost
effective way. The resulting mathematical model and analytic
methodology will identify optimal ASMP investment strategies,
maximizing the "value added" from proposed ASMP initiatives to
improve the Army's posture for achieving anticipated strategic
deployment objectives within applicable resource constraints.
The ultimate purpose is to aid in the preparation of the
Program Objective Memorandum (POM) and budget decision
processes.

b. Definitions:

(1) Value added is the marginal return on investment,
based on the effectiveness of various initiatives proposed
under ASMP to improve some aspect of strategic mobility,
relative to the costs of the initiatives.

(2) An ASMP initiative is a defined infrastructure
improvement, resource acquisition, capability enhancement,
or other similar action that uses funding resources to
enhance deployability of a specified Army force element.

c. Scope:

(1) Baseline program is President's Budget fiscal year
(FY) 94 and the U.S. Program Force (FY 95), or the latest
appropriate funding document.

(2) The analysis will examine the funding stream
associated with ASMP.

2

DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

(3) Approximately 500 ASMP initiatives, representing
large dollar amounts in current and proposed programs, will be
included. Inclusion of any particular initiative is subject to
the ability to effectively represent that initiative in terms of
data and modeling capability. ASMP initiatives will be
aggregated as necessary and appropriate.

(4) Scenarios and forces. The scenario and force
structure employed for the initial Mobility Requirements Study
(MRS) will be used for initial model development and validation
purposes. The end product model and methodology will be flexible
to accommodate varying scenarios and force structures.

d. Proposed Methodology. A mathematical programming model
will be developed based upon CAA's Value Added Analysis paradigm.
The model will be used to analyze candidate ASMP initiatives with
respect to costs and benefits, and will generate recommendations
regarding funding priorities and funding levels for proposed ASMP
initiatives.

e. Objectives:

(1) To assist USALEA in identification of objectives,
capabilities, and requirements to perform the subject analysis.
In particular, develop a mathematical modeling formulation and
determine data requirements to populate the resulting model.

(2) To develop a prototype implementation of the
modeling formulation. Test the prototype with notional data,
making corrections, improvements, and modifications as necessary.
This effort will be in collaboration with USALEA and will be
performed concurrently with their data collection effort to
ensure consistency between data and model.

(3) Test and continue the development effort using the
data collected and developed by USALEA.

(4) Conduct a demonstration of the refined model. This
will use the best available data obtained from authoritative
sources. Results of this analysis will form the Base Case for
this study.

(5) Support DALO-TSM in the POM building process as
necessary.

3

DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

f. Timeframe. Fiscal obligation analysis timeframe:
POM period FY 96 through FY 01.

g. Limitations. The optimization model will initially be
installed at CAA because the hardware and software required are
currently available only at CAA. Efforts will be made to provide
as much as possible of the developed capability, both data and
tools, to the sponsors and to USALEA for their use in internal
analyses.

h. Assumptions:

(1) The scenarios and forces used in the study will be
adequate to measure the effectiveness of candidate ASMP
initiatives.

(2) The measures of effectiveness (MOE) used for
purposes of this study accurately assess and express the effects
of implementing the proposed ASMP initiatives on the closure
times of Army units.

i. Essential Elements of Analysis (EEA):

(1) Does the proposed mathematical programming
formulation satisfy the analytic requirements of this study at
the required level of sensitivity?

(2) Taking force closure times as the primary MOE in
determining effectiveness of the candidate ASMP initiatives, what
allocation of available ASMP funds to the proposed initiatives
best enables the realization of overall force closure objectives?

(3) What ASMP initiatives, in what relative order of
priority, are recommended in the Base Case for procurement in the
Army POM?

6. RESPONSIBILITIES:

a. ODCSLOG (DALO-TSM) will:

(1) Provide a study sponsor representative and study
guidance.

(2) Provide support to the analysis for data required to
conduct the study.

4

DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

    b. USALEA will:

        (1) Provide a study representative and study guidance.

        (2) Collaborate in the development of the funding
prioritization model, primarily in a directive, advisory, or
consultive capacity.

        (3) Acquire, develop, and provide data required for
performance of the study.

    c. CAA will:

        (1) Conduct the ASMP funding prioritization modeling
study and analysis.

        (2) Designate a study director and provide the study
team.

        (3) Provide periodic in-process reviews (IPR) as
requested by the study sponsors.

7. REFERENCES: The Army Program Value Analysis (90-97) (CAA-SR-
91-9) and Army Program Value Analysis (94-99) (CAA-SR-92-10)
Reports provide the basis for the methodology and approach to
this study. Other references include the President's FY 94
Budget.

8. ADMINISTRATION:

    a. Support:

        (1) Funds for travel and/or per·diem will be provided by
the parent organizations of the individuals traveling.

        (2) ADP support will be provided by CAA.

        (3) Secretarial support, reports, and publication will
be provided by CAA.

    b. Key Milestones and Milestone Schedule.

Begin Model Development	1 Feb 94
Complete Prototype Model	14 Feb 94
Complete Prototype Testing	28 Mar 94
Full Scale Development Begins	1 Apr 94

DALO-TSM
SUBJECT: Study Directive: Prioritization of Army Strategic
Mobility Program (ASMP) Resources

Complete Base Case Demonstration .... 15 May 94
Preparation Complete to Support POM Development   1 Jun 94
Technical Effort Completed/Final IPR .... 30 Jun 94
Documentation Completed and Delivered .... 15 Sep 94

c. Control Procedure. The study sponsors' representatives
will coordinate and communicate within the HQDA staff and between
the ARSTAF and the study agency.

NORMAN E. WILLIAMS
Brigadier General, GS
Director of Transportation,
Energy and Troop Support

CF:
CDR, LEA

6

APPENDIX C

REFERENCES

DEPARTMENT OF DEFENSE

Department of Defense Publications

Military Traffic Management Command, Testing and Evaluation Agency

1. Memorandum, Henry M. Bennett, PE, Chief, Infrastructure Division, subject: Army Strategic Mobility Program (ASMP) Funding Prioritization Model, 13 January 1995

DEPARTMENT OF THE ARMY

Department of the Army Publications

Office of the Deputy Chief of Staff for Logistics

2. Memorandum, LTG J. M. Binford Peay, DCSOPS, and LTG Leon E. Salomon, DCSLOG, subject: Army Strategic Mobility Program (ASMP) Action Plan, 2 March 1993

3. DALO-TSM, Army Strategic Mobility Action Plan, 9 September 1994

US Army Concepts Analysis Agency

4. Southwest Asia Risk Analysis (SWA-RA I), CAA-MR-95-37, April 1995.

5. Southwest Asia Risk Analysis (SWA-RA II), CAA-MR-95-38, June 1995.

APPENDIX D

BIBLIOGRAPHY

DEPARTMENT OF DEFENSE

Department of Defense Publications

Joint Chiefs of Staff

JCS Publication, Mobilitly Requirements Study (MRS),Volume I, 23 January 1992

Military Traffic Management Command, Testing and Evaluation Agency

MTMCTEA Publication, Army Strategic Mobility Plan Study, Fort Stewart, Georgia, Final Report, Project Number 93-3a-18, January 1993

MTMCTEA Publication, A Study of Deployability Through the United States Strategic Ports, MTMCTEA Report SE 92-3g-46, April 1993

MTMCTEA Publication, Army Strategic Mobility Program Study, Fort Hood, Texas, Final Report, Project Number 92-3a-25, June 1993

MTMCTEA Publication, Army Strategic Mobility Program Study, Air Deployment, Fort Bliss, Texas, Final Report, Project Number 93-3a-35, May 1994

MTMCTEA Publication, Army Strategic Mobility Program Study, Fort Bliss, Texas, Final Report, Project Number 92-3a-26, June 1994

MTMCTEA Publication, Army Strategic Mobility Program Study, Fort Lewis, Washington, Final Report, Project Number 93-3a-53, October 1994

MTMCTEA Publication, Army Strategic Mobility Program Air Deployment Study, Robert Gray Army Airfield, Fort Hood, Texas, Draft Report, Project Number 94-3a-28, June 1995

DEPARTMENT OF THE ARMY

Department of Defense Publications

US Army Concepts Analysis Agency

Southwest Asia Risk Analysis (SWA-RA I), CAA-MR-95-37, April 1995

Southwest Asia Risk Analysis (SWA-RA II), CAA-MR-95-38, June 1995

MISCELLANEOUS

Williams, H. P. Model Building in Mathematical Programming. New York: John Wiley and Sons, 1978

Bradley, Stephen P., Arnoldo C. Hax, and Thomas L. Magnanti. Applied Mathematical Programming. Reading, MA: Addison-Wesley, 1977

IBM Corporation. Optimization Subroutine Library. New York: IBM Printing Office, 1990

APPENDIX E

PROPOSED USE OF GLOBAL DEPLOYMENT ANALYSIS SIMULATION (GDAS) MODEL

E-1. MODEL DESCRIPTION. GDAS is a transportation model that performs transportation analysis of large- or small-scale force deployments including mode planning, port selection, routing, scheduling, and simulation. The global transportation network model schedules from CONUS origins to intratheater destinations using intermodal, multitheater transport by air, sea, and land. GDAS includes integrated data base, query, world map display, chart graphics, simulation modeling, scheduling, analysis, and reporting capabilities. Special modeling features of GDAS include tracking of individual ship and aircraft locations, shortest path routing with node constraints for all modes, port facility throughput limitations with queuing, integrated air/sea/motor/rail mode selection, and time-phased dependency links between different movement requirements. GDAS operates on microcomputers using MS-DOS.

E-2. PURPOSE. In order to be able to evaluate initiatives individually rather than aggregated at the installation level, it is necessary to have a tool to evaluate the effect of funding each initiative. GDAS is being examined as a candidate tool. It may be used to evaluate the ASMP initiatives that are expected to improve the capability to transport equipment, materiel, and personnel.

   a. ASMP Requirements Studies. Data currently available from the MTMC-TEA ASMP requirements studies include information on the ability of a facility to meet its mission if certain initiatives are funded. This can be translated to benefits derived from implementation, and that is what was done for the prototype. However, the data aggregates initiatives together for each installation and was not derived in such a way as to allow information to be broken out for each individual initiative. In fact, only 20 percent of the initiatives have useful data for this source.

   b. Applicable Initiatives. The initiatives that require the acquisition of vehicles (railcars) and containers can be evaluated using GDAS. Those that improve the outload capability of a facility (railhead, container terminal, ocean terminal, airfield) can also be evaluated using the GDAS Model. These types of initiatives provide an improvement in capability that can be measured in short tons or measurement tons processed per day.

   c. Unsuitable Initiatives. Several types of initiatives included in the ASMP program are unsuitable for evaluation using GDAS. Initiatives related to the maintenance of existing facilities, automated systems, and training do not provide a clear, measurable improvement in capability, i.e., an increase in short tons or measurement tons processed per day. Tables E-1 through E-3 list those projects that were included in the ASMP program during the conduct of this study. The potential applicability of the GDAS Model in estimating their effectiveness is shown in the first column. There is a separate table for each appropriation type--MCA, OMA, and OPA.

E-3. STATUS. As of this writing, the data bases required to build the GDAS network for 13 major installations have been developed. As this is the first attempt at developing a CONUS network, debugging this complex structure has turned out to be extremely time-consuming and is not yet complete.

Table E-1. GDAS Candidate List for MCA-funded Initiatives
(page 1 of 2 pages)

GDAS applies	Item description	Impact location
Yes	Center Wharf Expansion	MOTSU
Yes	West Coast Ammo Port	Concord, CA
No	FT Bragg, Personnel Holding Facility	FT Bragg
No	Repair Airfield Runway Lighting	FT Bliss
Yes	West Coast Ammo Piers	Concord, CA
No	FT Bragg, Heavy Drop Rig Facility	FT Bragg
Maybe	A/DAAG Staging Complex	FT Bragg
Maybe	FT Bliss, Rail Deployment Facility Complex	FT Bliss
No	Maintenance Facility	Charleston, SC
Yes	FT Stewart, Rail Yard Expansion	FT Stewart
Maybe	Rail Yard Expansion	FT Carson
Yes	FT Sill, Rail System/Container Facility	FT Sill
Yes	Extend AFB (Fixed Wing Aircraft Parking)	FT Hood
No	Dredge Channel	MOTSU
No	PAX Process FAC CAAF	FT Campbell
No	FT Bliss, Air Deployment Facility	FT Bliss
Yes	FT Hood, Rail Phase I (4 Spurs/Container Facility)	FT Hood
Yes	FT Campbell, Hopkinsville Bypass	FT Campbell
No	Upgrade Main Pier	FT Eustis
No	Ammo Upload Facility	FT Stewart
No	Contingency Warehouse	FT Stewart
Yes	FT Campbell, Add Rail Tracks	FT Campbell
No	FT Bragg, Ammo Hold Facility	FT Bragg
No	Repair AF Taxiways/Aprons	FT Bliss
No	Repair Runway	FT Bliss
No	Green Ramp Phase I	FT Bragg
No	Contingency Stock Warehouse	FT Hood
Yes	FT Hood, Rail Phase II (3 Spurs/Stage Area)	FT Hood
Maybe	Rail Assembly Yard	Hawthorne AAP
Yes	FT Hood, Rail Phase III (4 Spurs/Track)	FT Hood
Yes	FT Stewart, Rail Marshaling Yard	FT Stewart
Yes	Additions To Wharf A	Charleston, SC
No	Standard Taxiways/Aprons	FT Hood
Yes	FT Benning, Rail Loading & Container Facility	FT Benning
Yes	Long-term Holding Facility	Sierra AD
No	Construct DAAG Facilities	FT Stewart
Yes	FT Polk, Rail Transfer Loading Facility	FT Polk
No	FT Bliss, Ammo Hot Load Area	FT Bliss
No	CADS Pad Upgrade	McAlester AAP
No	PREPO Container Road	Charleston, SC
No	Container DOL Warehouse	FT Sill
No	Airfield Parking Apron	FT Benning
Maybe	Railcar Holding Area	Crane AAP
No	Deployment Isolation Facility	FT Lewis

Table E-1. GDAS Candidate List for MCA-funded Initiatives
(page 2 of 2 pages)

GDAS applies	Item description	Impact location
No	Upgrade Ammo Pads	MOTSU
No	Deployment Training Facility	FT Eustis
Maybe	Blue Grass AD, Container Rail Load Sites	Blue Grass AD
Maybe	River Road Improvements	MOTSU
No	Renovate Deployment Hangar	FT Benning
No	Mobilization Warehouse	FT Benning
No	Deployment Facility McChord AFB	FT Lewis
No	Ammo Storage Facility	FT Bliss
No	Wharf A Marshaling Area	Charleston, SC
No	FT Stewart, Expand Access to Ammo Storage	FT Stewart
No	Mobilization Materiel Warehouse	FT Carson
Maybe	Fixed Wing Runway	FT Hood
No	Unit Movement Facility	FT Sill
Maybe	Runway Extension Lawson AAF	FT Benning
Yes	FT Stewart, Rail Pass Track	FT Stewart
Maybe	Road Network Improvements	Iowa AAP
Yes	Container Crane	MOTSU
No	Rail Track Repair	McAlester AAP
No	Contingency Storage Facility	FT Benning
No	Roadway Repair	McAlester AAP
Yes	Crane AAP, Container Transfer Facility	Crane AAP
No	Flight Control Tower	FT Stewart
No	Igloo Door Modifications	Blue Grass AD
No	Equipment Maintenance Facility	MOTSU
Yes	Rail Upgrade	Camp Roberts
No	Canopy For Cargo Transfer	MOTSU
Yes	Crane AAP, Container Stuffing Facility	Crane AAP
No	General Purpose Warehouse	FT Sill
No	Igloo Repairs	Milan AAP
Yes	Rail Upgrade	FT Bragg
Yes	Barge Loading Ramp	FT Campbell
Yes	Container Stuffing	Anniston AD
Yes	Enlarge Ammo Dock (Container Pad)	Red River AD
Yes	Loading Docks & Ramps	FT Carson
No	Ammo Holding Facility Lawson AAF	FT Benning
Yes	Rail Spur Track	McAlester AAP
Yes	Rail Upgrade	Camp Grayling
No	Container Repair Facility	Iowa AAP
No	Container Repair Facility Access Road	Iowa AAP

Table E-2. GDAS Candidate List for OMA-funded Initiatives
(page 1 of 3 pages)

GDAS applies	Item description	Impact location
No	Igloo Door Modifications	Blue Grass AD
Yes	RO/RO Ships (Start, O&S, Maintenance)	Theater
Yes	LMSR Ships I (Start, O&S, Maintenance)	Theater
Yes	LASH Ships (Start, O&S, Maintenance)	Theater
Yes	LMSR Ships II (Start, O&S, Maintenance)	Theater
Yes	Container Ships (Start, O&S, Maintenance)	Theater
No	Install Blocks II And III DAMMS-R	Europe
Yes	HLPS Ship I (Start, O&S, Maintenance)	SPOD
Yes	HLPS Ship II (Start, O&S, Maintenance)	SPOD
Yes	LMSR Ships III (Start, O&S, Maintenance)	Theater
No	Rail Track Upgrades (FORMAP)	FORSCOM installations
Yes	TACS Ship (Start, O&S, Maintenance)	SPOD
No	Maintain Operational AALPS/TCACCIS	All CONUS sites
Yes	Phase II Track	Hawthorne AAP
Yes	Upgrade Track	McAlester AAP
Yes	Containers, Sierra AD, Force Provider	Sierra, AD
Yes	Containers, FT Bragg, 82d Abn Div	FT Bragg
No	SEDRes At Port of Beaumont	Port of Beaumont
Yes	Containers, Kaiserslautern, Germany	aiserslautern
No	Install Blocks II And III DAMMS-R, Active	CONUS
No	Install Blocks II And III DAMMS-R, Reserve	CONUS
No	Install Blocks II And III DAMMS-R, National Guard	CONUS
No	Install Blocks II And III DAMMS-R	Korea
No	Repair Rails on Wharves	MOTSU
Yes	Containers, XVIII Abn Corps and 1st COSCOM	FT Bragg
No	Indian Reservation Track Repairs (Phase I)	Hawthorne AAP
No	Road Repairs	Hawthorne AAP
Yes	Rail Upgrade	Blue Grass AD
Maybe	Hawthorne AAP, CADS Facility	Hawthorne AAP
Yes	Anniston AD, Container Facility	Anniston AD
Yes	Containers, FT Stewart, 24th ID (Mech)	FT Stewart
Yes	Rail Rehabilitation	Hawthorne AAP
Yes	Upgrade Track	Anniston AD
No	SEDRes at Port Of Savannah	Savannah
No	SEDRes at Port Of Jacksonville	Jacksonville
No	Rail Repair	MOTSU
No	Integrate AALPS/TCACCIS on Std Hardware	All CONUS sites
Yes	Upgrade Track (Includes Container Support Facility)	Tooele AD
Yes	Containers, FT Campbell, 101st ASSLt Div	FT Campbell
Yes	Containers, FT Richardson, 6th ID (Lt)	FT Richardson
Yes	Incoming Rail Yard	Blue Grass AD

Table E-2. GDAS Candidate List for OMA-funded Initiatives
(page 2 of 3 pages)

GDAS applies	Item description	Impact location
Yes	Rail Upgrade	Red River AD
No	Annual Maintenance Dredging	MOTSU
No	Repair Fenders	MOTSU
Yes	Containers, Camp Darby, Italy	CP. Darby, IT
Yes	Containers, FT Hood, III Corps and 13th COSCOM	FT Hood
Yes	Containers, FT Lewis, 7th Inf Div (Lt)	FT Lewis
Yes	Containers, FT Hood, 1st Cav Div	FT Hood
Yes	Rail Upgrade	FT Eustis
Yes	Containers, Schofield Barracks, 25th ID (Lt)	Schofield Barracks
Yes	Containers, USAR Units (Unspecified)	Various
Yes	Containers, FT Bliss, 3d ACR	FT Bliss
Yes	Rail Upgrade	FT Sill
Yes	Rail Upgrade	Seneca AD
Yes	Rail Upgrade	FT Chaffee
No	Operate Joint Strategic Deployment Training Center	Universal
No	Roadway Repair	Milan AAP
Yes	Containers, FT Drum, 10th Mountain Div (Lt)	FT Drum
No	Develop IDP-4 for TCACCIS	All CONUS Sites
No	Implement Phase II In-transit Visibility (ITV)	
No	Strategic Deployment Analysis	Ports
Yes	Containers, Bad Kreuznach Germany	Bad Kreuznach GE
Yes	Containers, Hawthorne AAP	Hawthorne AAP
Yes	Containers, Schweinfurt Germany	Schweinfurt GE
Yes	Containers, Wuerzburg Germany	Wuerzburg GE
Maybe	Renovate S-12 Pier	MOTSU
Yes	Containers, Baumholder Germany	Baumholder GE
Yes	Containers, Vicenza It	Vicenza IT
Yes	Containers, Crane AAP	Crane AAP
Yes	Containers, Anniston Army Depot	Anniston AD
Yes	Containers, McAlester AAP	McAlester AAP
Yes	Containers, Lexington - Blue Grass Army Depot	Lexington - Blue Grass AD
No	Milan AAP, Track Repairs	Milan AAP
Yes	Containers, Darmstadt Germany	Darmstadt GE
Yes	Containers, Sierra Army Depot	Sierra AD
No	Army Containerization Integration Office	Various
Yes	Containers, Milan AAP	Milan AAP
Yes	Containers, USASOC, 7th Special Forces Gp	
No	Savanna Army Depot, Railroad Repairs	Savanna AD
Yes	Containers, Letterkenny Army Depot	Letterkenny AD
Yes	Containers, Red River Army Depot	Red River AD
Yes	Containers, USASOC, SOIC WDSTAA	

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Table E-2. GDAS Candidate List for OMA-funded Initiatives
(page 3 of 3 pages)

GDAS applies	Item description	Impact location
No	Missile Sheds	Red River AD
No	Arterial Road	Red River AD
Yes	Extend Docks	Red River AD
No	MTMC Warfighter Deployment Interface Program	Ports
Yes	Containers, Tooele AAP	Tooele AAP
Yes	Containers, Seneca Army Depot	Seneca AD
Yes	Containers, USASOC, 528th SOS	
Yes	Containers, Grafenwoehr Germany	Grafenwoehr GE
Yes	Containers, USASOC, 351 CA (Res)	
Yes	Containers, USASOC, 352 CA (Res)	
Yes	Containers, USASOC, 358 CA (Res)	
Yes	Containers, USASOC, 361 CA (Res)	
Yes	Containers, USASOC, SOIC WC3JAA	
Yes	Containers, USASOC, 353 CA (Res)	
Yes	Containers, USASOC, 12th Special Forces Gp (Res)	
Yes	Containers, USASOC, 5th Special Forces Gp	
Yes	Tiger Teams for Port Opening	Ports
Yes	Full Time Presence At Strategic Ports	Ports
Yes	Containers, USASOC, 112th Signal	
Yes	Containers, USASOC, 96th CA	
Yes	Containers, USASOC, 4th PSYOP Gp	
Yes	Containers, Savannah Army Depot	Savannah AD
Yes	Containers, USASOC, 2^{d} PSYOP Gp (Res)	
Yes	Containers, USASOC, 7th Special Forces Gp (Res)	

Table E-3. GDAS Candidate List for OPA-funded Initiatives
(page 1 of 2 pages)

GDAS applies	Item description	Impact location
Yes	Railcars, FT Bliss	FT Bliss
Yes	Railcars, FT Hood	FT Hood
Yes	Railcars, FT Campbell	FT Campbell
Yes	Railcars, FT Benning	FT Benning
Yes	Railcars, FT Stewart	FT Stewart
No	Complete FOC TCACCIS	All CONUS sites
Yes	Railcars, Hawthorne AAP	Hawthorne AAP
No	Field TCACCIS IDP-4	All CONUS sites
Yes	Railcars, US Marine Corps	
Yes	Railcars, Crane AAP	Crane AAP
Yes	Railcars, Anniston Army Depot	Anniston AD
Yes	Railcars, McAlester AAP	McAlester AAP
Yes	Railcars, Lexington-Blue Grass Army Depot	Blue Grass AD
Yes	Container Lift Device, 82^d Airborne Div	
Yes	Container Lift Device, 10th Mountain Div (Lt In)	
Yes	Container Lift Device, 101st Air Asslt Div	
Yes	Container Lift Device, 24th Inf Div (Mech)	
Yes	Container Lift Device, 1st Cav Div	
Yes	Container Lift Device, 2^d Inf Div (Mech)	
Yes	Container Lift Device, 1st Armor Div	
Yes	Container Lift Device, 25th Inf Div (Lt)	
Yes	Container Lift Device, 2^d Armor Div	
Yes	Container Lift Device, 4th Inf Div (Mech)	
Yes	Railcars, Sierra Army Depot	Sierra AD
Yes	Railcars, Milan AAP	Milan AAP
No	TCACCIS Connectivity, FTs to CONUS Ports	All CONUS sites
Yes	Railcars, Red River Army Depot	Red River AD
Yes	Railcars, Letterkenny Army Depot	Letterkenny AD

Table E-3. GDAS Candidate List for OPA-funded Initiatives
(page 2 of 2 pages)

GDAS applies	Item description	Impact location
Yes	CHE Stewart	Stewart
Yes	CHE Bragg	Bragg
Yes	CHE Campbell	Campbell
Yes	CHE Hood	Hood
Yes	CHE Carson	Carson
Yes	CHE Drum	Drum
Yes	CHE Lewis	Lewis
Yes	CHE Benning	Benning
Yes	CHE Sill	Sill
Yes	CHE Polk	Polk
Yes	CHE Bliss	Bliss
Yes	CHE Riley	Riley
Yes	CHE Irwin	Irwin
Yes	CHE Anniston	Anniston
Yes	CHE Bluegrass	Bluegrass
Yes	CHE Charleston	Charleston
Yes	CHE Crane	Crane
Yes	CHE Hawthorne	Hawthorne
Yes	CHE Letterkenny	Letterkenny
Yes	CHE McAlester	McAlester
Yes	CHE Red River	Red River
Yes	CHE Tooele	Tooele
Yes	Railcars, Tooele AAP	Tooele AAP
Yes	Railcars, Seneca Army Depot	Seneca AD
Yes	Railcars, Savannah Army Depot	Savannah AD

APPENDIX F

PASMPR OPTIMIZATION MODEL FOR PROTOTYPE

F-1. MODEL DESCRIPTION. The optimization model developed for the PASMPR prototype formulation interfaces with the IBM Optimization Subroutine Library (OSL). The formulation that it implements is identified in Figure 3-5.

F-2. THE FORTRAN CODE. The following model is a matrix generator and post-processor, written in FORTRAN 77, which provides information concerning variables, constraints, coefficients, and the objective function in a manner which is proscribed by OSL:

```
C               (PASMPR2)
C*****************************************************************************
C
                              PROGRAM ASMPOP
C
C*****************************************************************************
C *** Input Variable Definitions
C*****************************************************************************
C *** NUNITS.....................(i) number of unit packages
C *** NINIT.......................(j) number of ASMP initiatives or aggregated initiatives
C *** NYR.........................(k) number of years in study, generally the pom cycle
C *** NAPP........................(l) number of appropriation types, i.e., OMA, OPA, MCA
C *** NOPT........................ total number of procurement options combinations
C *** XI(j).........................holds the index of funded initiatives
C *** JPROC(NOPT,NY..........0 if no procurement (y) for opt p, in year k
C *** ...................................1 if yes procurement (y) for init j, in year k
C *** JPNONZ.....................jproc zero elements
C *** PINIT(j).......................place location of initiative j
C *** LOPTYR(p)...................last yr of procurement for init j
C *** FCOST(NINIT,NAPP).....fixed cost of init, by appropriation type
C *** VCOST(NINIT,NAPP).....variable cost of init, by appropriation type
C *** B(NYR,NAPP)...............yearly budget, by approp
C *** MEFFB(NUNIT,NINIT)...marginal effectiveness beta, fixed delta in closure of
C ***                              unit i, given j is procured
C *** MEFFA(NUNIT,NINIT)...marginal effectiveness beta, delta in closure of i given 1
C ***                                increment of j
C *** WUNIT(NUNIT).............weight or priority of unit
C *** PCLOSE(NUNIT)...........present closure time of unit
C *** RCLOSE(NUNIT)...........required closure time of unit
C *** MAXDEV(NUNIT)..........max deviation in closure time allowed for unit i
C *** MINQ(NINIT,NYR)........min procurement of j in yr k
C *** MAXQ(NINIT,NYR).......max procurement of j in yr k
C *** TMINQ(NINIT)..............total min procurement of j, for all years
C *** TMAXQ(NINIT).............total min procurement of j, for all years
C*****************************************************************************
C *** Decision Variable Definitions
C*****************************************************************************
C *** X(p,j)...........................1, if option p of init j is funded; 0, otherwise
C *** Y(p,j,k).........................quantity of init j procured in year k by option p
C *** Z(i).............................positive deviations in closure time of unit i
```

```
C***************************************************************
C *** Define Problem Variables
C***************************************************************
C  Include the OSL definitions
      INCLUDE (OSLR)
      INCLUDE (OSLI)
      INCLUDE (OSLN)
      IMPLICIT NONE
      INTEGER*4   NINIT, NUNIT, NYR, NAPP,MAXIN,MAXUN,MAXTYP,
     &            MAXOPT,MAXYR, MAXAPP
      PARAMETER (MAXIN=50, MAXUN=50, MAXYR=6, MAXAPP=3,
     &            MAXTYP=6, MAXOPT=200)
      INTEGER*4   JPROC(MAXOPT,MAXYR),
     &            MINQ(MAXIN,MAXYR),
     &            MAXQ(MAXIN,MAXYR),
     &            TMINQ(MAXIN),
     &            TMAXQ(MAXIN),
     &            APPTYP(MAXIN,MAXAPP),
     &            JINDX,
     &            UNINDX,
     &            BEGIND(MAXTYP),
     &            ENDIND(MAXTYP),
     &            IOPT,
     &            NTYPE,
     &            TYPINIT(MAXTYP),
     &            TINIT(MAXIN),
     &            QIND(MAXIN),
     &            NOPT,
     &            TOTYR(MAXOPT),
     &            LOPTYR(MAXOPT),
     &            PMINDX,
     &            NDXPTR(MAXOPT),
     &            NROW,
     &            J01,
     &            J02,
     &            J0,
     &            I,M,L,J,K,
     &            NINITS,
     &            IDUMYR,
     &            IFLAG,
     &            J1,
     &            ISUMVC,
     &            PYR(MAXOPT,MAXYR),
     &            OPT(MAXOPT),
     &            JPNONZ,
     &            NICNTR,
     &            XI(MAXIN),
     &            PINIT(MAXIN),
     &            NPMETH
C
      REAL*8      FCOST(MAXIN,MAXAPP),
     &            VCOST(MAXIN,MAXAPP),
     &            MEFFB(MAXUN,MAXIN),
     &            MEFFA(MAXUN,MAXIN),
     &            WUNIT(MAXUN),
     &            PCLOSE(MAXUN),
     &            RCLOSE(MAXUN),
     &            MAXDEV(MAXUN),
```

```
    &               SUMWU,
    &               B(MAXYR,MAXAPP),
    &               OBJARR(MAXIN),
    &               TOTOBJ,
    &               COSTARR(MAXIN,MAXYR,MAXAPP),
    &               YCAPP(MAXYR,MAXAPP),
    &               TCAPP(MAXAPP),
    &               TCYEAR(MAXYR),
    &               TINCAPP(MAXIN,MAXYR)

    CHARACTER*8 CINIT(MAXIN),
    &               CUNIT,
    &               DUMRED,
    &               UNNAME(MAXIN)
C***********************************************************************
C *** Define Decision Variables
C***********************************************************************
C
    INTEGER*4 X(MAXOPT),
    &         Y(MAXOPT,MAXYR)
    REAL*8    Z(MAXIN)


C***********************************************************************
C *** Define OSL Variables
C***********************************************************************
    INTEGER*4 IRL, ICL, IEL, NUMX, IRU, IDELS, NINTS, NSETS,
    &         IVCNTR, NUMY, NUMZ, NCOL, NEL, ITYPE, RTCOD,
    &         MXSPACE
    PARAMETER (IRL= 5000, ICL= 5000, IEL= 12000,
    &         MXSPACE = 11500000, ITYPE=1)
    REAL*8    DRLO(IRL), DRUP(IRL), DCLO(ICL), DCUP(ICL),
    &         DOBJ(ICL), DELS(IEL), DSPACE(MXSPACE),
    &         DNPCOST, UPPCOST
    INTEGER*4 IA(IEL), JA(IEL), MINT(500), NTSIZE, PRI(1),
    &         IMDLTP(1), NSETIN(1), NSSETS(1) ,ANSWER(66)
C***********************************************************************
C *** Initialize Arrays
C***********************************************************************
C *** For problem variables:  *********************************
C
    READ(15,*) NINIT,NUNIT,NYR,NTYPE,NAPP

    DO 10 J = 1, NINIT
      DO 20 K = 1, NYR
        JPROC(J,K) = 0
        MINQ(J,K) = 0
        MAXQ(J,K) = 0
        DO 30, L = 1, NAPP
          FCOST(J,L) = 0.0D0
          VCOST(J,L) = 0.0D0
30      CONTINUE
20    CONTINUE
10  CONTINUE
C
    DO 40 K = 1, NYR
      DO 50 L = 1, NAPP
        B(K,L) = 0.0D0
50    CONTINUE
```

```
40   CONTINUE
C
     DO 60 I = 1, NUNIT
       DO 70 J = 1, NINIT
         MEFFB(I,J) = 0.0D0
         MEFFA(I,J) = 0.0D0
70     CONTINUE
60   CONTINUE
C
C *** For OSL Variables:  *************************************
C
     DO 80 M = 1, IRL
       DRLO(M) = 0.0D0
       DRUP(M) = 0.0D0
80   CONTINUE
C
     DO 81 M = 1, ICL
       DCLO(M) = 0.0D0
       DCUP(M) = 0.0D0
       DOBJ(M) = 0.0D0
81   CONTINUE
C
     DO 82 M = 1, NINITS
       MINT(M) = 0
82   CONTINUE
C
     DO 83 M = 1, IEL
       IA(M) = 0.0D0
       JA(M) = 0.0D0
       DELS(M) = 0.0D0

83   CONTINUE
C
     IRU = 0
     IDELS = 0
C
C**************************************************************
C *** Read input variables, beginning with JPROC matrix, so that
C ***    comparisons can be made back to jproc to see if there is
C ***    an expected entry for that init-year combo expected.
C****************************************************************
C
     ISUMVC = 0
     J1 = 0
     IFLAG = 0
     DO 110 J = 1, NINIT
       READ (16,*) JINDX, TINIT(J), CINIT(J),
     &          (APPTYP(J,L),L=1,NAPP),TMINQ(J),
     &          TMAXQ(J), (FCOST(J,L), L =1,NAPP),
     &          (VCOST(J,L), L=1,NAPP), QIND(J),  PINIT(J)

C for the short term, until better data is available, set the yearly min
C max to  TMAXQ respectively, later in the constraints, the model will determine
C how much it will put in each year.based on a 10 % variance +/- that we allow from the max divided by total years in
the option choosen.

       DO 111 K = 1, NYR
         MINQ(J,K) = TMAXQ(J)
```

```
            MAXQ(J,K) = TMAXQ(J)
111     CONTINUE
110   CONTINUE

120   READ (20,*) JINDX, UNINDX, MEFFA(UNINDX,JINDX),
     &          MEFFB(UNINDX,JINDX), DUMRED

      IF ( MEFFA(UNINDX,JINDX) .NE. 0.0D0 .AND. QIND(JINDX) .EQ.0 )THEN
        WRITE(6,*) 'INIT ',JINDX,' UNIT ',UNINDX, ' HAS MEFFA W/O X.'
        IFLAG = 1
      ENDIF
      IF (DUMRED .EQ. ' ' ) GO TO 120

C *** read budget limits by yr and appropriation type
      WRITE(8,*) 'BUDGET LIMITS BY YEAR AND APPROPRIATION'
      DO 140 K = 1, NYR
         READ (17, *) IDUMYR, ( B(K,L), L = 1, NAPP)
         WRITE (8, *) 'YEAR ',IDUMYR, ( B(K,L), L = 1, NAPP)
140   CONTINUE
C

      SUMWU = 0.0
      DO 160 I = 1, NUNIT
        READ(18, *) UNINDX, UNNAME(I), WUNIT(I)
        SUMWU = SUMWU + WUNIT(I)
C
C *** Check to see that unit weights (priorities) do not sum to more than 1.0.
C
      IF (SUMWU .GT. 1.0 ) WRITE (7,*) 'UNIT WEIGHT',
     &    ' (PRIORITIES) EXCEED ALLOWABLE TOTAL OF 1.O AS ',
     &    'OF UNIT ', I

160   CONTINUE

C *** Read table of possible procurement methods, and lookup table cross-
C       reference for which methods are used for which init types.

      READ(19,* ) NPMETH
      WRITE(6,*) 'NPMETH = ',NPMETH
      DO 165 L = 1, NPMETH
        READ(19,*) PMINDX,(PYR(PMINDX,K),K=1,NYR)
        WRITE(6,*) PMINDX,(PYR(PMINDX,K),K=1,NYR)
165   CONTINUE
      WRITE(6,*) 'TYPE INFORMATION'
      DO 166 L = 1, NTYPE
        READ (19,*) TYPINIT(L), BEGIND(TYPINIT(L)),ENDIND(TYPINIT(L))
        WRITE(6,*) TYPINIT(L), BEGIND(TYPINIT(L)),ENDIND(TYPINIT(L))
166   CONTINUE

      WRITE(6,*) 'INIT INFORMATION'
      DO 170 J= 1,NINIT
        WRITE(6,*) J, BEGIND(TINIT(J)),ENDIND(TINIT(J))
        DO 171 IOPT = BEGIND(TINIT(J)),ENDIND(TINIT(J))
          NOPT = NOPT + 1
          OPT(NOPT) = J
          NDXPTR(NOPT) = IOPT
          DO 172 K = 1, NYR
            IF ( PYR(NDXPTR(NOPT),K) .EQ. 1 ) THEN
```

```
                    LOPTYR(NOPT) = K
                    TOTYR(NOPT) = TOTYR(NOPT) + 1
                 ENDIF
172       CONTINUE
          WRITE(6,*) IOPT,NOPT, OPT(NOPT),LOPTYR(NOPT)
     &        ,TOTYR(NOPT)
171    CONTINUE
170  CONTINUE

C *** set up jproc from pyr matrix:

     DO 175 J0 = 1,NOPT
       J = OPT(J0)
       WRITE(6,*) J, BEGIND(TINIT(J)),ENDIND(TINIT(J))
         DO 177 K = 1, NYR
            JPROC(J0,K) = PYR(NDXPTR(J0),K)
177       CONTINUE
175  CONTINUE


C*****************************************************************
C *** Set upper and lower bounds of decision variables and number the nonzero
C *** elements of jproc.
C*****************************************************************
C*** for debug purposes, print contents of jproc before renumbering occurs:
     WRITE (6,*) 'PRIOR TO RENUMBERING JPROC:'
     WRITE (6,*) 'J0','OPT(J))','TINIT','JPROC'

     DO 178 J0 = 1, NOPT
       WRITE (6,*)  J0,OPT(J0),TINIT(OPT(J0)),(JPROC(J0,K),K=1,NYR)
178  CONTINUE

C *** For the binary elements in jproc:
     JPNONZ = 0
     IVCNTR = NOPT
     DO 180 J0 = 1, NOPT
       MINT(J0) = J0
       DCLO(J0) = 0.0D0
       DCUP(J0) = 1.0D31
       DO 200 K = 1, NYR
         IF ( JPROC(J0,K) .EQ. 1 ) THEN
           JPNONZ = JPNONZ + 1
           JPROC(J0,K) = JPNONZ + NOPT
           IF (QIND(OPT(J0)) .EQ. 0 ) THEN
             IVCNTR = IVCNTR + 1
             MINT(IVCNTR) = JPROC(J0,K)
             DCLO(JPNONZ+NOPT) = 0.0D0
             DCUP(JPNONZ+NOPT) = 1.0D31
           ELSE
             NICNTR = NICNTR + 1
             DCLO(JPNONZ+NOPT) = 0.0D0
             DCUP(JPNONZ+NOPT) = TMAXQ(OPT(J0))
           ENDIF
         ENDIF
200    CONTINUE

C*** for debug purposes, print contents of jproc after renumbering occurs:
     WRITE (6,*) 'AFTER RENUMBERING JPROC:'
     WRITE (6,*) 'JPROC OF J0(',J0,') =',(JPROC(J0,K),K=1,NYR)
```

```
 180  CONTINUE
      NINTS = IVCNTR
      WRITE(6,*)'NONZEROS ',JPNONZ+NOPT,' INTS ',IVCNTR,
    &      ' NONINT ',NICNTR
C*****************************************************************
C *** For each contraint, convert coefficients for non-zero elements, rhs, and lhs
C *** into dspace matrix.
C*****************************************************************
C *** Constraint set 1 -- Budget constraints
C
      WRITE (6,*) 'CONSTRAINT SET 1:  IDELS ',IDELS, ' IRU ',IRU
      WRITE(8,*) 'BUDGET CONSTRAINT ENTRIES'
      DO 220 K  = 1, NYR
        DO 230 L = 1, NAPP
          IRU = IRU + 1
          DO 240 J0 = 1, NOPT
C *** if variable cost exist:
            IF (JPROC(J0,K) .NE. 0 ) THEN
              IF ((QIND(OPT(J0)) .EQ. 1) .AND.
    &             (VCOST(OPT(J0),L) .NE. 0.0D0)) THEN
                WRITE(8,*) 'OPT ',J0,
    &             ' INIT ',OPT(J0),' YEAR ',K,' APP ',L
    &             , VCOST(OPT(J0),L)*DCUP(JPROC(J0,K)),
    &               DCLO(JPROC(J0,K)), QIND(OPT(J0))
                IDELS = IDELS + 1
                IA(IDELS) = IRU
                JA(IDELS) = JPROC(J0,K)
                DELS(IDELS) = VCOST(OPT(J0),L)
              ELSEIF ((QIND(OPT(J0)) .EQ. 0) .AND.
    &             (FCOST(OPT(J0),L) .NE. 0.0D0)) THEN
                WRITE(8,*) 'OPT ',J0,
    &             ' INIT ',OPT(J0),' YEAR ',K,' APP ',L
    &             , DCUP(JPROC(J0,K))*FCOST(OPT(J0),L)
    &               / TOTYR(J0),QIND(OPT(J0))
                IDELS = IDELS + 1
                IA(IDELS) = IRU
                JA(IDELS) = JPROC(J0,K)
                DELS(IDELS) = FCOST(OPT(J0),L)/ TOTYR(J0)
              ENDIF
            ENDIF
 240      CONTINUE
C
C *** Rhs:
          DRLO(IRU) = 0.0D0
          DRUP(IRU) = B(K,L)

 230    CONTINUE
 220  CONTINUE
C*****************************************************************
C *** Constraint set 2 -- only 1 procurement method may be used per init
C
      WRITE (6,*) 'CONSTRAINT SET 2:  IDELS ',IDELS, ' IRU ',IRU
C
      DO 250 J = 1,NINIT
        IRU = IRU + 1
        DO 260 J0 = 1, NOPT
          IF ( OPT(J0) .EQ. J ) THEN
```

```
                  IDELS = IDELS + 1
                  IA(IDELS) = IRU
                  JA(IDELS) = J0
                  DELS(IDELS) = 1.0D0
               ENDIF
260     CONTINUE
C *** Rhs:
        DRLO(IRU) = 0.0D0
        DRUP(IRU) = 1.0D0
250   CONTINUE

C
C****************************************************************
C *** Constraint set 3 -- Yearly Procurement min and max quantities:
C
      WRITE (6,*) 'CONSTRAINT SET 3: IDELS ',IDELS, ' IRU ',IRU
C
      DO 280 J0  = 1, NOPT
        DO 290 K  = 1, NYR
          IF (JPROC(J0,K) .NE.0.AND.
     &        QIND(OPT(J0)).EQ.1) THEN
              IRU = IRU + 1
              IDELS = IDELS + 1
              IA(IDELS) = IRU
              JA(IDELS) = J0
              DELS(IDELS) = (-MAXQ(OPT(J0),K) / TOTYR(J0) )*1.1D0
              IDELS = IDELS + 1
              IA(IDELS) = IRU
              JA(IDELS) = JPROC(J0,K)
              DELS(IDELS) = 1.0D0
              DRLO(IRU) = (MINQ(OPT(J0),K) / TOTYR(J0) ) * 0.9D0 -
     &                  ( MAXQ(OPT(J0),K) / TOTYR(J0) ) * 1.1D0
              DRUP(IRU) = 0.0D0
          ENDIF
290     CONTINUE
280   CONTINUE
C
C****************************************************************
C *** Constraint set 4 -- Total Procurement quantites:
C
      WRITE (6,*) 'CONSTRAINT SET 4: IDELS ',IDELS, ' IRU ',IRU
C
      DO 320 J0 = 1, NOPT
        IF(QIND(OPT(J0)).EQ.1) THEN
           IRU = IRU + 1
C *** binary piece:
           IDELS = IDELS + 1
           IA(IDELS) = IRU
           JA(IDELS) = J0
           DELS(IDELS) = -TMAXQ(OPT(J0))
C
           DO 330 K  = 1, NYR
             IF (JPROC(J0,K) .NE.0) THEN
C *** non-binary piece:
                IDELS = IDELS + 1
                IA(IDELS) = IRU
                JA(IDELS) = JPROC(J0,K)
                DELS(IDELS) = 1.0D0
```

```
          ENDIF
330       CONTINUE
C * * *  to make an equality constraint, make up and lo both 0.
          DRLO(IRU) = 0.0D0
          DRUP(IRU) = 0.0D0
     ELSE
C * * * * The variables are integer and must have the same value as the opt variable
          DO 325 K  = 1, NYR
            IF (JPROC(J0,K) .NE.0) THEN
              IRU = IRU + 1
              IDELS = IDELS + 1
              IA(IDELS) = IRU
              JA(IDELS) = JPROC(J0,K)
              DELS(IDELS) = -1.0D0
              IDELS = IDELS + 1
              IA(IDELS) = IRU
             .JA(IDELS) = J0
              DELS(IDELS) =  1.0D0
              DRLO(IRU) = 0.0D0
              DRUP(IRU) = 0.0D0
            ENDIF
325       CONTINUE
     ENDIF
320 CONTINUE


C****************************************************************
C * * *  clique constraints -- insure that infrastructure for an installation must be in its
C * * *    final year of procurement before the rail or container buys can be made.
C * * *  therfore, if 2 opts in same loc, want to prevent lastyr of j02 from being greater
C * * *  than lastyr of j01, so constrain it such. z3 + z2 < = 1

     WRITE (6,*) 'CLIQUE CON SET 1:  IDELS ',IDELS, ' IRU ',IRU

     DO 335 J01 = 1, NOPT
       IF (( TINIT(OPT(J01)) .EQ. 2) .OR.
     &     (TINIT(OPT(J01)) .EQ.3)) THEN
         DO 336 J02 = 1, NOPT
C * * *  check if second init is an infrastructure, and if  in the same place as the 1st.
           IF ((TINIT(OPT(J02)).EQ.4 .OR. TINIT(OPT(J02)).EQ.5)
     &         .AND.(PINIT(OPT(J01)) .EQ. PINIT(OPT(J02)))) THEN
C * * *  last year of procurement for option1 should be after infra is complete
             IF(LOPTYR(J01) .LT. LOPTYR(J02))THEN
                IRU = IRU + 1
                IDELS = IDELS + 1
                IA(IDELS) = IRU
                JA(IDELS) = J01
                DELS(IDELS) = 1.0D0
                IDELS = IDELS + 1
                IA(IDELS) = IRU
                JA(IDELS) = J02
               ·DELS(IDELS) = 1.0D0
                DRLO(IRU) =  0.0D0
                DRUP(IRU) = 1.0D0
             ENDIF
           ENDIF
336       CONTINUE
     ENDIF
335 CONTINUE
```

```
C *** This temporary code forces in infrastructure projects.
     DO 340 J = 1,NINIT
       IF(TINIT(J).EQ.0) THEN
         IRU = IRU + 1
         DO 342 J0 = 1,NOPT
           IF(OPT(J0).EQ.J) THEN
             IDELS = IDELS + 1
             IA(IDELS) = IRU
             JA(IDELS) = J0
             DELS(IDELS) = 1.0D0
           ENDIF
342      CONTINUE
         DRLO(IRU) = 1.0D0
         DRUP(IRU) = 1.0D0
       ENDIF
340  CONTINUE
C

C*************************************************************
C *** Objective function: SUM BetaX + AlphaY

     DO 360 I = 1, NUNIT
       DO 370 J0 = 1, NOPT
C ***        assume that effects are assessed at end of last year of procurement:
             DOBJ(JPROC(J0,LOPTYR(J0))) =
     &            MEFFA(I,OPT(J0))
     &          + MEFFB(I,OPT(J0))
     &          + DOBJ(JPROC(J0,LOPTYR(J0)))
370    CONTINUE
360  CONTINUE
     DO 369 J0 = 1, NOPT
         WRITE(6,*) 'DOBJ ',J0,JPROC(J0,LOPTYR(J0)),
     &        DOBJ(JPROC(J0,LOPTYR(J0)))
369  CONTINUE
C*************************************************************
C *** OSL Specific Variables:
C
     NROW = IRU
     NCOL = IVCNTR + NICNTR
     NEL = IDELS
     NSETS = 0
C*************************************************************
     DO 800 I = 1,NCOL
       WRITE(6,*) 'LL ',DCLO(I),' UL ',DCUP(I),' VAR ',I
800  CONTINUE
C *** OSL Model Setup:
C
C *** Describe application and specify that there is 1 model:
     CALL EKKDSCA (RTCOD, DSPACE, MXSPACE, 1)
     IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKDSCA', RTCOD )
C
C *** Set messages to be used with SMAP:
     CALL EKKMSET( RTCOD, DSPACE,83,0,270,0,0,83,0 )
     IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKMSET', RTCOD )
C
C *** Describe the model:
     CALL EKKDSCM ( RTCOD, DSPACE,1,1 )
     IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKDSCM', RTCOD )
```

```
C
C *** Specify Minimization problem:
      CALL EKKRGET ( RTCOD, DSPACE, OSLR, OSLRLN )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKRGET', RTCOD )
C *** specify a maximization:
      RMAXMIN = -1.0D0
      RMUINIT = 1000.0D0
      RTOLPINF = 10.0D-7
C
      CALL EKKRSET( RTCOD, DSPACE, OSLR, OSLRLN )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKRSET', RTCOD )
C
C *** Specify the integer variables:
      CALL EKKIGET ( RTCOD, DSPACE, OSLI, OSLILN )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKIGET', RTCOD )
C
      IMAXINTS = 5000
      IMAXROWS = 100000
      CALL EKKISET ( RTCOD, DSPACE, OSLI, OSLILN )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKISET', RTCOD )
C
C *** Pass the model the new matrix stored by indices:
C
      CALL EKKLMDL ( RTCOD, DSPACE, ITYPE, NROW, NCOL, NEL,
     &          DOBJ), DRLO, DRUP, DCLO, DCUP, IA, JA,DELS )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKLMDL', RTCOD )
      NSETS = 0
C
      CALL EKKIGET ( RTCOD, DSPACE, OSLI, OSLILN )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKIGET', RTCOD )
C
      CALL EKKIMDL(RTCOD,DSPACE,NINTS,MINT,NSETS,IMDLTP,
     +        PRI,NTSIZE,NSETIN,NSSETS,DNPCOST,UPPCOST)
      IF (RTCOD .GT. 0) CALL CHKRT('EKKIMDL',RTCOD)
C
C*******************************************************************
C *** OSL Debug output:
C
      DO 500, I = 1, IDELS
        WRITE (8, *)I,' IA= ',IA(I),' JA= ', JA(I),' DELS= ',DELS(I)
500   CONTINUE
C
      WRITE (8,*) 'ROW BOUNDS'
      DO 510, I = 1, IRU
        WRITE (8,*) I, ' DRLO= ', DRLO(I), ' DRUP = ', DRUP(I)
510   CONTINUE
C
      WRITE (8,*) 'COLUMN BOUNDS'
      DO 520, I = 1, NCOL
        WRITE (8,*) I, ' DCLO= ', DCLO(I), ' DCUP = ', DCUP(I)
520   CONTINUE
C
      WRITE (8,*) 'OBJ FUNCTION'
      DO 530, I = 1, NCOL
        WRITE (8,*) I, '  OBJ= ', DOBJ(I)
530   CONTINUE
C
      WRITE (8,*) 'INTEGER VARIABLES'
```

```
      DO 540, I = 1, NINTS
        WRITE (8,*) I, ' MINT= ', MINT(I)
540   CONTINUE
C
C *** Set the quantity of output to produce:
      CALL EKKMSET( RTCOD, DSPACE,87,0,-1,0,0,102,0 )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKMSET', RTCOD )
C
C *** Print problem statistics:
C
      CALL EKKSTAT(RTCOD, DSPACE)
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKSTAT', RTCOD )
C
C *** Scale the coefficient matrix:
C
C     CALL EKKSCAL(RTCOD, DSPACE)
C     IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKSCAL', RTCOD )
C
C *** Solve the mip, will assume simplex to be used for linear relaxation:
C *** Unit 10 is for matrix info, unit 11 is for basis info; type 1 implies start from
C ***     the beginning, whereas a 2 would mean to restart:
C     CALL EKKSSLV(RTCOD, DSPACE,1,1)
      CALL EKKMPRE(RTCOD,DSPACE,1)
      IF(RTCOD.GT.0) CALL CHKRT('EKKMPRE',RTCOD)
      CALL EKKMSLV(RTCOD, DSPACE,1,10,11)
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKMSLV', RTCOD )
C
C *** Call the routine to print the answer:
      CALL EKKPRTS(RTCOD, DSPACE)
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKPRTS', RTCOD )
C
      CALL EKKIGET ( RTCOD, DSPACE, OSLI, OSLILN )
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKIGET', RTCOD )
C
C *** Call the routine to get location of solution arrays in DSPACE:
      CALL EKKNGET ( RTCOD, DSPACE, ANSWER,66)
      IF ( RTCOD .GT. 0 ) CALL CHKRT ( 'EKKNGET', RTCOD )
C
C*************************************************************
C *** Convert OSL solution to accessible output:
C
C *** Initialize decision arrays to store output variables:
C
      DO 600, J0 = 1,NOPT
        X(J0) = 0
C
        DO 610, K = 1,NYR
          Y(J0,K) = 0
610     CONTINUE
600   CONTINUE
C
      DO 620, I = I, NUNIT
        Z(I) = 0.0D0
620   CONTINUE
C
C*************************************************************
C *** Get answers out of DSPACE, note that answer(7) is pointing to 1st element
C ***     of solution (column activities):
```

```
C
      DO 700, J0 = 1, NOPT

        IF( DSPACE(ANSWER(7) + J0-1).GE.0.995D0) X(J0)=1
        WRITE (9,*) J0, ' X(', J0, ')= ', X(J0)
C
        DO  710, K = 1, NYR
          IF(JPROC(J0,K).NE.0) THEN
            IF( DSPACE(ANSWER(7)+JPROC(J0,K) -1).LT.0.995D0) THEN
              Y(J0,K) = 0.0D0
              WRITE (9,*) J0, ' Y(', J0, ',', K, ')= ', Y(J0,K)

            ELSEIF(( DSPACE(ANSWER(7)+JPROC(J0,K) -1).GE.0.995D0)
     &                            .AND.
     &        ( DSPACE(ANSWER(7)+JPROC(J0,K) -1).LE.1.005D0))THEN
              Y(J0,K)=1
              WRITE (9,*) J0, ' Y(', J0, ',', K, ')= ', Y(J0,K)

            ELSE
              Y(J0,K) =DSPACE(ANSWER(7)+JPROC(J0,K) -1)

              WRITE (9,*) J0, ' Y(', J0, ',', K, ')= ', Y(J0,K)
            ENDIF
          ENDIF
710     CONTINUE
700   CONTINUE
C
      DO 730 J = 1, NINIT
        DO 740 J0 = 1, NOPT
          IF ( (J .EQ. OPT(J0)) .AND. (X(J0) .EQ. 1)) THEN
            XI(J) = 1
            WRITE (9,*) J, ' INIT ', XI(J), ' PROG ',
     &              (Y(J0,K),K=1,NYR)
          ENDIF
740     CONTINUE
730   CONTINUE

c *** calculate the objective function value
C Put OBJ values in array for each initiative
C
      DO 750 J0 = 1, NOPT
        IF ( X(J0) .EQ. 1) THEN
          DO 760 I = 1, NUNIT
            OBJARR(OPT(J0)) = OBJARR(OPT(J0)) + MEFFA(I,OPT(J0)) +
     &                            MEFFB(I,OPT(J0))
760       CONTINUE
          TOTOBJ = TOTOBJ + OBJARR(OPT(J0))

          WRITE(9,*) 'OPT(J0) ',OPT(J0),'OBJARR ',
     &         OBJARR(OPT(J0)),' TOTOBJ ',TOTOBJ

        ENDIF
750   CONTINUE

C *** calculate and print the cost for each initiative by year, appropriation
C ***   and totals
      WRITE (9,*) 'YEARLY TOTALS BY APPROPRIATION:'
      DO 770 K = 1, NYR
```

```
          DO 780 L = 1, NAPP
            DO 790 J0 = 1, NOPT
              IF (X(J0) .EQ. 1) THEN
                If ( QIND(OPT(J0)) .EQ. 1) THEN
                  COSTARR(OPT(J0),K,L) = Y(J0,K)*VCOST(OPT(J0),L)
                ELSE
                  COSTARR(OPT(J0),K,L) = Y(J0,K)*FCOST(OPT(J0),L)
     &                                    / TOTYR(J0)
                ENDIF
                YCAPP(K,L) = YCAPP(K,L) + COSTARR(OPT(J0),K,L)
              ENDIF
790         CONTINUE
          TCAPP(L) = TCAPP(L) + YCAPP(K,L)
780       CONTINUE
            WRITE(9,1040) (YCAPP(K,L),L=1,NAPP)
770   CONTINUE
1040  FORMAT(1X,6(F8.3,',',1X))

      WRITE (9,*) 'DEBUG TO CROSSCHK QTY AND COSTS:'
      DO 765 J0 = 1, NOPT
        DO 766 K = 1, NYR
          DO 767 L = 1, NAPP
            TINCAPP(OPT(J0),K)=TINCAPP(OPT(J0),K) +
     &         COSTARR(OPT(J0),K,L)
767         CONTINUE
766       CONTINUE
        IF (X(J0) .EQ. 1) THEN
          WRITE (9,1050) OPT(J0), (Y(J0,K),K=1,NYR)
          WRITE (9,1051) (TINCAPP(OPT(J0),K),K = 1, NYR)
        ENDIF
765   CONTINUE
1050   FORMAT(1X,I3,',',1X,6(I8,',',1X))
1051   FORMAT(1X,6(F8.3,',',1X))

      WRITE(9,*) 'YEARLY COST TOTALS (TCYEAR):'
      DO 792 L = 1, NAPP
        DO 791 K = 1, NYR
          TCYEAR(K) = TCYEAR(K) + YCAPP(K,L)
791     CONTINUE
      WRITE(9,1300) (TCYEAR(K),K = 1, NYR)
792   CONTINUE
1300  FORMAT(1X,6(F8.3,',',1X))

      WRITE(9,*) ' COST OF INITS BY APPROP AND YEAR (COSTARR):'
      DO 795 J = 1, NINIT
      WRITE(9,1250) J, CINIT(J)
        DO 796 L = 1, NAPP
          WRITE(9,1200) (COSTARR(J,K,L),K = 1,NYR)
796     CONTINUE
795   CONTINUE
1200  FORMAT(1X,6(F8.3,',',1X))
1250  FORMAT(1X,I3,1X,A8)

C  Print out the objective values and quantities of each INITIATIVE
      WRITE (9,*) 'OBJECTIVE ARRAY'
      DO 820 J = 1,NINIT
        WRITE (9,1100) J, CINIT(J), OBJARR(J)
820   CONTINUE
```

```
1100  FORMAT(1X, I3, 1X, A8, 1X, F8.3)

C *** print out values in dspace for debug:
      WRITE(9,*) 'IPROBSTAT = ', IPROBSTAT, ' OBJ VALUE = ',TOTOBJ
C     DO 861 I=ANSWER(7),ANSWER(8)
C        WRITE(9,1002) I,DSPACE(I)
C 1002    FORMAT(1X,'I = ',I7,5X,'DSPACE ',F10.2)

C
c *** print the cost of each init funded and the total by appropriation and year:


      STOP
      END

C**************************************************************
C *** This subroutine prints out an error message when an OSL subroutine returns
C ***    an error code.
C
      SUBROUTINE CHKRT (RTNAME, RTCOD)
      CHARACTER*7 RTNAME
      INTEGER*4  RTCOD
C
      WRITE (7,10) RTNAME, RTCOD
10    FORMAT ( 1X,'******* ', A7, ' RETURN CODE OF ',I4, ' *******')
      IF (RTCOD .GT. 200 ) STOP 16
      RETURN
      END
C**************************************************************
```

APPENDIX G

INITIATIVES INPUT FILE

G-1. USAGE. The following data is the prototype initiative input file for the PASMPR optimization model. The types of initiatives used include SEDRES excersises, 20-foot to 80-foot container purchases, railcar purchases, infrastructure improvements, and PREPO readiness facilitities and ships. The definititions of these initiatives are defined in great detail in the Army Strategic Mobility Plan.[2] Two types of costs are possible for each initiative, fixed (FC) or variable (VC). There are three appropriation types possible as a source of funding for each initiative: MCA, OMA, or OPA. The minimum and maximum procurement quantity possible for each initiative is represented by MINQ and MAXQ, respectively. VFLG is a variable that indicates whether an inititiative has an associated variable or fixed cost. The location of an initiative is given in the LOC field. A key to these locations follows the file.

Init	Type	Description	MCA	OMA	OPA	MINQ	MAXQ	MCAFC	OMAFC	OPAFC	MCAVC	OMAVC	OPAVC	VFLG	LOC
1	1	'SEDRESP1'	0	1	0	2	12	0	36	0	0	0	0	0	7
2	1	'SEDRESP2'	0	1	0	3	16	0	54	0	0	0	0	0	8
3	1	'SEDRESP3'	0	1	0	2	12	0	36	0	0	0	0	0	9
4	2	'CON1CSCM'	0	1	0	0	270	0	0	0	0	0.007609	0	1	1
5	2	'CON1DIVN'	0	1	0	0	448	0	0	0	0	0.007482	0	1	1
6	2	'CON1CORP'	0	1	0	0	219	0	0	0	0	0.008744	0	1	1
7	2	'CON2CORP'	0	1	0	0	370	0	0	0	0	0.007215	0	1	2
8	2	'CON2DIVN'	0	1	0	0	271	0	0	0	0	0.007719	0	1	2
9	2	'CON2CSCM'	0	1	0	0	612	0	0	0	0	0.00815	0	1	2
10	2	'CON3MECH'	0	1	0	0	1280	0	0	0	0	0.007295	0	1	3
11	2	'CON4ASLT'	0	1	0	0	427	0	0	0	0	0.00745	0	1	4
12	2	'CON53ACR'	0	1	0	0	333	0	0	0	0	0.008243	0	1	5
13	2	'CON13SPT'	0	1	0	0	3096	0	0	0	0	0.006	0	1	13
14	2	'CON12OTR'	0	1	0	0	1438	0	0	0	0	0.0081	0	1	12
15	2	'CON14RES'	0	1	0	0	552	0	0	0	0	0.005	0	1	14
16	3	'RAILCAR3'	0	0	1	0	127	0	0	0	0	0	0.11	1	3
17	3	'RAILCAR6'	0	0	1	0	139	0	0	0	0	0	0.11	1	6
18	3	'RAILCAR1'	0	0	1	0	437	0	0	0	0	0	0.11	1	1
19	3	'RAILCAR4'	0	0	1	0	200	0	0	0	0	0	0.11	1	4
20	3	'RAILCAR5'	0	0	1	0	609	0	0	0	0	0	0.11	1	5
21	3	'RAILCA15'	0	0	1	0	30	0	0	0	0	0	0.11	1	15
22	3	'RAILCA17'	0	0	1	0	196	0	0	0	0	0	0.11	1	17
23	5	'INFROMA5'	1	0	0	0	1	0	0.6	0	0	0	0	0	5
24	5	'INFROMA4'	1	0	0	0	1	0	0.7	0	0	0	0	0	4
25	5	'INFROM16'	1	0	0	0	1	0	22	0	0	0	0	0	16
26	4	'INFRMCA5'	1	0	0	0	1	96.4	0	0	0	0	0	0	5
27	4	'INFRMCA4'	1	0	0	0	1	21	0	0	0	0	0	0	4
28	4	'INFRMCA3'	1	0	0	0	1	36.5	0	0	0	0	0	0	3
29	4	'INFRMCA6'	1	0	0	0	1	42.6	0	0	0	0	0	0	6
30	4	'INFRMCA2'	1	0	0	0	1	51.5	0	0	0	0	0	0	2
31	4	'INFRMCA1'	1	0	0	0	1	87.3	0	0	0	0	0	0	1
32	4	'INFRMC10'	1	0	0	0	1	35.1	0	0	0	0	0	0	10
33	4	'INFRMC11'	1	0	0	0	1	55	0	0	0	0	0	0	11
34	4	'INFRMC16'	1	0	0	0	1	562	0	0	0	0	0	0	16
35	1	'PREPREAD'	0	1	0	0	1	0	1629	0	0	0	0	0	18
36	1	'PREPOL10'	0	1	0	0	1	0	56.7	0	0	0	0	0	10
37	1	'PREPOL11'	0	1	0	0	1	0	43.3	0	0	0	0	0	11

G-2. FIELD LOCATIONS. The location codes below allow the model to put constraints on inititiatives either coming from the same "location", or effecting the same "location"

1 Ft Hood	7 Port of Savannah	13 Support and sustainment base
2 Ft Bragg	8 Port of Beaumont	14 USAR
3 Ft Stewart	9 Port of Jacksonville	15 USMC
4 Ft Campbell	10 General readiness, near	16 All other infrastructure
5 Ft Bliss	11 General readiness, far	17 AAPs and Depots
6 Ft Benning	12 Other divisions	18 PREPO Readiness facility, Charleston, SC

APPENDIX H

UNITS INPUT FILE

USAGE. The following data is the prototype units input file for the PASMPR optimization model. The purpose of this file is to tie the index number and an importance weight to a particular unit description. Due to the sensitivity of the data, the weights in this file have been set to 1.0 for all units. For purposes of the prototype, the weights are meaningful only in that the model has been demonstrated to be sensitive to the weights applied, and initiatives that affect heavier weighted units are preferred over others, all else being the same.

Unit index	Unit identifier	Importance weight
1	'HD13CSCM'	1
2	'HD1STCAV'	1
3	'HD3CORPS'	1
4	'BG18CORP'	1
5	'BG82ABN1'	1
6	'BG82ABN2'	1
7	'BG1STCSM'	1
8	'ST24MECH'	1
9	'1BDE101S'	1
10	'3RDACREG'	1
11	'2BDE101S'	1
12	'HVSEPBDE'	1
13	'SUSTBASE'	1
14	'OTRFORCE'	1
15	'GENRDNSS'	1

APPENDIX I

EFFECTIVENESS INPUT FILE

USAGE. The following data is the prototype unit input file for the PASMPR optimization model. More than one unit can be affected by the same initiative. More than one initiative can affect the same unit. Marginal effectiveness relates to initiatives that can be procured in varied amounts and have an associated marginal cost. Effectiveness is measured in days of improvement. For initiative 4, a 7 in effectiveness denotes a 7-day decrease in the time required to deploy unit 1 if initiative 4 is procured. Note that at the time the demo was performed, no effectiveness estimates were available for initiatives 23 and 24. The sponsor decided to include them with zero days of improvement. Fixed effectiveness relates to initiatives that are buy or no-buy decisions and have only a fixed cost component. The empty quotes at the end of the file signify the end of the record.

Initiative index	Affected unit	Marginal effectiveness	Fixed effectiveness		
1	8	0.2	0	'	'
2	2	0.3	0	'	'
3	9	0.06	0	'	'
3	11	0.14	0	'	'
4	1	0	7	'	'
5	2	0	21	'	'
6	3	0	14	'	'
7	4	0	28	'	'
8	6	0	14	'	'
9	7	0	7	'	'
9	7	0	7	'	'
10	8	0	21	'	'
11	11	0	14	'	'
12	10	0	7	'	'
13	13	0	0.0068	'	'
14	14	0	0.001	'	'
15	14	0	0.001	'	'
16	8	0	18	'	'
17	12	0	6	'	'
18	2	0	18	'	'
18	3	0	12	'	'
18	1	0	6	'	'
19	11	0	12	'	'
20	10	0	6	'	'
21	14	0	0.005	'	'
22	13	0	0.0918	'	'
23	10	0	0	'	'
24	11	0	0	'	'
25	13	0.0031	0	'	'
26	10	1.6	0	'	'
27	11	4.5	0	'	'
28	8	0.8	0	'	'
29	12	1.4	0	'	'
30	5	0.67	0	'	'
30	6	1	0	'	'
31	1	2.4	0	'	'
31	2	2.4	0	'	'
31	3	2.4	0	'	'
32	15	1	0	'	'
33	15	1	0	'	'
34	13	0.0031	0	'	'
35	15	1	0	'	'
36	15	1	0	'	'
37	15	1	0	'	enddata '

APPENDIX J

SPONSOR'S COMMENTS

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
500 ARMY PENTAGON
WASHINGTON DC 20310-0500

1 8 DEC 1996

DALO-TSM

MEMORANDUM FOR DIRECTOR, U.S. ARMY CONCEPTS ANALYSIS AGENCY,
8120 WOODMONT AVENUE, BETHESDA, MD 20814-2797

SUBJECT: Prioritization of the Army Mobility Project Resources
(PASMPR) Draft

1. Reference CSCA-VA memorandum of 6 Sep 19996, subject as
above.

2. Concur with draft report and distribution as written.
Written evaluation is provided at encl.

3. POC for this action is LTC Hart, 703-614-6608.

FOR THE DEPUTY CHIEF OF STAFF FOR LOGISTICS:

Encl

BOYD E. KING
Brigadier General, GS
Director for Transportation,
Energy and Troop Support

STUDY CRITIQUE

(This document may be modified to add more space for responses to questions.)

1. Are there any editorial comments? __No__ If so, please list on a separate page and attach to the critique sheet.

2. Identify any key issues planned for analysis that are not adequately addressed in the report. Indicate the scope of the additional analysis needed. __None__

_____

_____

3. How can the methodology used to conduct the study be improved?

Methodology was sufficient. _____

_____

_____

4. What additional information should be included in the study report to more clearly demonstrate the bases for the study findings? _____
None. _____

_____

5. How can the study findings be better presented to support the needs of both action officers and decisionmakers? _____
N/A. _____

_____

6. How can the written material in the report be improved in terms of clarity of presentation, completeness, and style? _____
Current presentation sufficient. _____

_____

STUDY CRITIQUE (continued)

7. How can figures and tables in the report be made more clear and helpful?

Current presentation sufficient.

8. In what way does the report satisfy the expectations that were present when the work was directed?

N/A.

In what ways does the report fail to satisfy the expectations?

N/A.

9. How will the findings in this report be helpful to the organization which directed that the work be done?

N/A.

If they will not be helpful, please explain why not.

N/A.

10. Judged overall, how do you rate the study? (circle one)

Poor   Fair   Average   Good   (Excellent)

2

APPENDIX K

DISTRIBUTION

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GLOSSARY

1. ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

AAP   Army ammunition point

ASMP   Army Strategic Mobility Program

CAA   US Army Concepts Analysis Agency

CINC   commander in chief

CONUS   continental United States

COSCOM   corps support command

CS/CSS   combat support/combat service support

DA   Department of the Army

DOD   Department of Defense

EEA   essential element(s) of analysis

FY   fiscal year

ITV   in-transit visibility

MIP   mixed integer program

MCA   Military Construction, Army

MOE   measure(s) of effectiveness

MOTSU   Military Ocean Terminal, Sunny Point

MP   mathematical programming

MRS   Mobility Requirements Study

MRS BURU   Mobility Requirements Study Bottom-Up Review

MTMC-TEA   Military Traffic Management Command Transportation Engineering Agency

ODCSLOG	Office of the Deputy Chief of Staff for Logistics
OMA	Operation and Maintenance, Army
OPA	Other Procurement, Army
OSL	Optimization Subroutine Library
POM	Program Objective Memorandum
PREPO	prepositioned
QRA	quick reaction analysis
RRF	Ready Reserve Force
SEDRES	seaport emergency deployment readiness exercise
SWA	Southwest Asia
TETS	Directorate of Transportation, Energy, and Troop Support
TPFDD	Time-Phased Force Deployment Data
TTU	transportation terminal unit
USALIA	United States Army Logistic Integration Agency
USAR	United States Army Reserve
USMC	United States Marine Corps
WC	west coast

2. TERMS UNIQUE TO THIS STUDY

PASMPR	Prioritization of Army Strategic Mobility Program Resources
SAMSONITE	Strategic Army Mobility: Survey of National Infrastructure, Technology, and Equipment

3. MODELS, ROUTINES, AND SIMULATIONS

GDAS

Global Deployment Analysis System. GDAS is a transportation model that performs transportation analysis of large- or small-scale force deployments including mode planning, port selection, routing, scheduling, and simulation. The global transportation network model schedules from CONUS origins to intratheater destinations using intermodal, multitheater transport by air, sea, and land. GDAS includes integrated data base, query, world-map display, chart graphics, simulation modeling, scheduling, analysis, and reporting capabilities. Special modeling features of GDAS include tracking of individual ship and aircraft locations, shortest path routing with node constraints for all modes, port facility throughput limitations with queuing, integrated air/sea/motor/rail mode selection, and time-phased dependency links between different movement requirements. GDAS operates on microcomputers using MS-DOS.

4. DEFINITIONS

value added

The marginal return on investment, based on the effectiveness of various initiatives proposed under ASMP to improve some aspect of strategic mobility, relative to the costs of the initiatives.

ASMP initiative

A defined infrastructure improvement, resource acquisition, capability enhancement, or other similar action that uses funding resources to enhance deployability of a specified Army force element.